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Systems thinking: Strengthening health systems in practice

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Systems thinking: Strengthening health systems in practice

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Fostering Resilient Health Systems in India: Providing Care for PLHIV Under the Shadow of COVID-19

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Introduction: The novel coronavirus or COVID-19 has resulted in major human casualties, and extreme socio-economic crises causing catastrophic disturbances to health systems and communities alike. This study qualitatively explores the challenges experienced by healthcare providers while providing services to people living with HIV (PLHIV) during the pandemic outbreak and subsequent lockdown in India. The paper also explores strategies developed and adopted to provide continued care for PLHIV.

Methods: Using an empirical phenomenological approach, qualitative in-depth telephonic interviews were conducted with 19 HIV care providers from five states in India. The recorded interviews were transcribed and analyzed using inductive thematic analysis with the help of Dedoose software.

Results: From the analysis of participants' narratives, three main themes emerged: (1) Challenges of working during a pandemic; (2) Remodeling care delivery to ensure continuity of services; (3) Resilience.

Discussion: Our findings highlight the challenges that providers faced, despite which, adaptive efforts were made to continue providing quality care for PLHIV through ingenious and innovative strategies. To foster resilient health systems, health workers are the primary stakeholders. We recommend formal social protection, comprehensive primary healthcare support, and sufficient capacity building for health workers for their self-care and pandemic preparedness.

Keywords: HIV, COVID-19, healthcare providers, resilience, health system

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INTRODUCTION

The novel coronavirus or COVID-19, has resulted in major human casualties, and socio-economic crises causing catastrophic disturbances to health systems and communities alike. What followed was a shift in the priorities of governments and scientific communities to focus entirely on COVID, pushing everything else to the sidelines (1). To handle the immense strain caused by COVID-19 on health systems, equipment and providers were reallocated to the pandemic response. These changes adopted by nations posed a serious threat to the advances made in the control of diseases like HIV among others, by affecting the delivery of services as well as access to treatment and care (2). Care providers were asked to forego the ongoing, critical needs of People Living with HIV (PLHIV) which led to significant disruption in service delivery (3).

While the world debates and makes amends to equip health systems to battle COVID-19, there is a matter that is equally alarming, yet neglected - the wellbeing of health care workers (HCWs) and the impact of this pandemic on their physical and mental health. Healthcare providers (HCPs) have the highest risk for contracting the virus, because of the nature of their job- caring for infected patients and being in contaminated environments. Recent studies suggest that there is an increase in the prevalence of mental health problems among HCPs, especially frontline workers (4). The disproportionate risk of getting infected, along with a higher workload and inadequate working conditions might have a bearing on their psycho-physiological status (5, 6). Similar findings have been reported in studies conducted among HCWs during the 2003 SARS outbreak too (5). A recent study that compared mental health outcomes among medical and non-medical trained staff revealed that the prevalence of anxiety was higher among non-medical staff (7). HIV care providers where the workforce comprises medical and non-medical professionals like counselors, technicians, etc. might be particularly vulnerable to mental health problems as they operate in an intersecting space of COVID and HIV.

The ability to adapt and prevail in the face of adversities, or to be resilient is important while dealing with crisis situations. Findings from a systematic review indicate that resilience has a protective effect on negative stressors and mental outcomes like anxiety, depression, etc (8). While HCPs are known for their emotional resilience and fortitude, the challenges posed by this pandemic were certainly novel as the name suggested, making it difficult for providers to cope. Working tirelessly to provide care for a disease that spreads through human-to-human contact, fear of not knowing enough about the virus, and lack of a specific treatment certainly magnifies the stress of the providers and will in turn affect the quality of care (9, 10). A recent study among healthcare workers in Indonesia identified that higher levels of anxiety were significantly associated with lower levels of resilience (10).

While many sources affect the wellbeing of the health workers as part of their health system experience, it is important to identify these stressors and concurrent coping mechanisms to prevent further burnout as well as strengthen support mechanisms. This study aims to do a qualitative exploration of the challenges experienced by HIV care providers while providing services during the pandemic outbreak and subsequent lockdown in India as well as any solutions adopted to overcome the crisis.

METHODS

Study Design

Using an empirical phenomenological approach, a qualitative study through telephonic in-depth interviews was conducted with health care workers providing care for PLHIV in five states of India. This research approach is considerably influenced by "phenomenology" which deals with the study of phenomena, how things appear or occur. Phenomenological qualitative research aims to understand experiences and meanings within the context in which a particular experience takes place (11). Therefore in-depth interviews using a semi-structured guide were used as the primary method of investigation in our study. The provider interviews were conducted as part of a larger study exploring the disruptions experienced by PLHIV while accessing sexual reproductive health rights and services during the COVID-19 pandemic and subsequent lockdown in India which occurred from March to May 2020 (12).

Participants and Settings

The study was conducted with HIV providers from five states in India-Karnataka (KR), Andhra Pradesh (AP), Telangana (TS), Tamil Nadu (TN), and Maharashtra (MH). These particular sites were chosen since according to the recent estimation of key indicators for prioritizing HIV/AIDS programs in India, these were among the 15 top states where HIV-specific unmet needs were greatest (13). Further, these states have an adult HIV prevalence higher than the national average and were among the top six states with the highest mortality from AIDS (14). In addition, since coronavirus cases were steadily increasing at these places (15), and the strong professional relationship Swasti[1] has with around 60 Community-based Organizations (CBOs) for over two decades, is what made us choose these five states as our study states.

Taking into account the experience CBOs have in working with health systems, especially those providing care for PLHIV, they were used to recruit participants in the study. Participants were sampled using purposive sampling with a maximum variation technique to get diverse opinions of challenges experienced by different health care workers. While the participants were recruited from different streams to diversify the sample, the interviews continued till no further information was coming forth from the participant narratives or till saturation was achieved. Only those individuals who have been providing services to PLHIV for at least 2 years were included in the study, to ensure that they had ample experience with the health system.

Data Collection

Data was collected *via* in-depth telephonic interviews which ranged from 45 to 60 min. A semi-structured interview guide was developed and piloted with a few HIV care providers to test the validity of topics. Based on the observations from the pilot, the guide was modified and a final version of the tool was made, after deliberate consensus within the research team. This tool was then translated into the local language for ease of data collection.

The interviews were conducted by a four member research team from August to October 2020, just after the first wave was considered to be over. Two researchers were there on each call (one as interviewer and one as moderator and to take notes), along with the participant. Before commencing the interview the purpose of the study was explained to the participant in detail and verbal consent was obtained for their voluntary participation as well as recording the interview. Even though the lockdown was over in some of the states during the time of conducting the study,

[1]Swasti is a not-for-profit organization headquartered in Bangalore established in 2002, focusing on achieving health outcomes, especially for socially excluded and marginalized communities.

there were still restrictions in many parts of the states which affected the movement and access to health care for communities, as well as providers. Keeping this in mind, we encouraged the participants to share their experiences of disruptions during the official lockdown and the period after. Interviews were conducted till data saturation was obtained, a point where no further information emerged from the participants' narrative of their experience.

Ethical Considerations

Since the study involved human participants, all procedures were carried out per the ethical standards of the Catalyst Group Institutional Review Board, and ethical approval was taken from the same. Study participants were informed telephonically about the study details, as well as any possible risks before data collection. Only once informed consent was obtained, the data collection procedure began. Providers were also told that they could stop the interviews at any point, and skip any question which they weren't comfortable with. Furthermore, high levels of confidentiality were ensured with strict measures taken to protect the respondents' identity. Although participant names and the details of the facilities they work in were asked for the interviews, once transcription was done, codes were given to each participant so that their identity remained masked. Any identifiable information of theirs would not be disclosed in any report, research paper, or presentation. Moreover, although consent was taken to record the telephonic conversations, these recordings would not be shared with anybody other than the research team and they are stored in password-protected drives with limited access.

Data Analysis

All the interviews were transcribed into English by a team of transcriptionists and 25% of the transcripts were randomly cross-checked with the original recordings to ensure the quality of the transcriptions. The transcripts were uploaded to Dedoose - a software used to support qualitative data analysis and was analyzed using "inductive thematic analysis." The research team underwent in-depth training on how to use Dedoose to code, analyze and export data from the transcripts.

For analyzing the data using thematic analysis, the team used the guidelines put forth by Braun and Clarke (16). The first step in the process of analysis was familiarizing with the data, which involved reading the transcripts multiple times and making extensive notes on the researcher's initial thoughts and what patterns have been identified in the data. In the next step, codes were generated based on certain features of the data like commonly occurring patterns in the transcripts or main points that were discussed in each interview. Using Dedoose, phrases, sentences, and paragraphs were highlighted and given tags to match the codes. Once the entire dataset was coded like this, the team met virtually to discuss and review each other's coding and continued to the next phase of generating themes. From the codebook generated from Dedoose, the codes were grouped together based on similarities and differences. At this point, some codes that were not particularly relevant to the phenomenon that was being discussed were discarded. Once the teams were in agreement on the final list of themes and sub-themes, the themes were given clear names and succinctly defined to convey what they represented and how each of them fit into the larger narrative. The final stage of the analysis was detailing everything that happened as part of the study, right from the introduction to the final narrative of results, discussion, and conclusions which are discussed in different sections in this paper.

RESULTS

A total of 19 participants from five states, shared their experiences of providing care during the COVID-19 pandemic and subsequent lockdown, as well as the mitigating measures adopted to ensure service delivery. Among the participants, we had four nurses, four doctors, four program personnel, five counselors, and two field workers. On average, the providers have been working with the PLHIV for 11 years. The mean age of the participants was 42 and the sample included nine females, eight males, and one transwoman. Ten were working in the public sector and nine were from the private sector.

From the analysis of participants' narratives, three main themes emerged: (1) Challenges of working during a pandemic; (2) Remodeling care delivery to ensure continuity of services; (3) Resilience.

Challenges of Working During a Pandemic

This theme details the challenges experienced by the providers at multiple levels while providing care for PLHIV during the pandemic and subsequent lockdown. The challenges are described in three separate sub-themes—systemic, community level, and personal.

Systemic Disruptions in Service Delivery

The first subtheme describes the disruptions that occurred in the HIV healthcare sector and how that affected the service delivery as well as access to care.

Providers reported that the facilities were suspended for months together, partially and sometimes completely due to the stringent lockdowns in all of the states included in our study. There was a considerable delay, and sometimes an almost complete cessation in the provision of routine healthcare services including supportive care, as well as routine screening and testing. Even when supplies were available, the unavailability of transportation and the unwillingness of staff to travel, due to fear of COVID-19 resulted in a delay in procuring the necessary supplies.

> *"Earlier, on an average 100–150 clients will meet one counselor each day for proper counseling. Due to lockdown, there was no treatment provided, and counseling did not happen too." - 50, ART Counselor, TN*

> *"For the first few months, we didn't have proper supply. Funding was there. But to bring the available resources, we didn't have proper transport, human resources...staff was not willing to go to far off places." - 47, ART Doctor, KR*

The priorities given to the healthcare staff for handling the pandemic situation interrupted the service delivery in all aspects—funding and equipment got diverted, providers got shifted to COVID duty, and hospitals became COVID-19 care centers. As a result, providers were not able to care for any illness other than COVID-19 and had to reject help to patients on multiple occasions.

"Our entire lab was converted to COVID-19 virology so they closed it all down. The CD4 machines, both the lab technicians were officially assigned to Covid duties...So, lab technicians are very important to us... They did the duty for more than 6 months...so the testing completely stopped…It completely stopped." - 35, ART Doctor, AP-TS

"There was no admission here at the health center for PLHIV patients facing difficulty at any time even during the lockdown due to COVID-19 care. PLHIV people still are not allowed admission in GH, they are facing trouble getting care as COVID-19 cases or treatment is the main priority." - 41, Program Staff, TN

The majority of the providers, with the exception of a few, mentioned that while there was a clear directive to ensure continuity of services for PLHIV, there was a general lack of planning and preparedness to handle the crisis situation, in terms of arranging transportation, allocating budget and other resources, information communication, etc.

"We had a disruption in the transportation of medications… Though the papers and everything said the Postal Service has opened up and will take the essential drugs, it was for diabetes, heart disease, etc.

Nobody mentioned anything about PLHIV." - 54, Primary care Physician, KR

"Sir, if the office had arranged vehicles for us to travel, it'd have been very easy for facilitating services. But it was not there." 45, Outreach Worker, KR

"This issue of shortage of staff is omnipresent. We see this problem in all the departments. This is due to less manpower. In the initial days, we found it quite difficult. Firstly, we had to finish our work, and then we were asked to perform the call duty for COVID counseling. Then we were placed in the COVID centers, to counsel COVID and non-COVID patients." - 42, ART Counselor, MH

Patient and Community Level Setbacks

The second sub-theme describes the challenges faced by the providers because of the effect of the pandemic on the care-seeking behavior of PLHIV communities.

The unavailability and unaffordability of transport services along with the crippling fear and exacerbated stigma that surfaced with COVID-19, resulted in the majority of PLHIV refraining from seeking care. A considerable number of respondents also mentioned that the PLHIV were hesitant to seek care because of health centers becoming COVID care centers.

"PLHIV could not turn up and have tests due to lack of proper transport, some could not have masks and condoms.…Those living in rural areas could not come to the center and avail medicines." 49, ICTC counselor, AP-TS

"Yes madam, they are well aware of the consequences of missing the medicine but they are ready to take that risk to protect their identity. They will say that they will somehow manage to find some money and come back in a month and buy medicines from here itself." 39, ART Nurse, KR

Another important challenge was the changes in the attitudes and behaviors of patients. Due to the restrictions that were implemented in the health centers, it was reported that the patients were not trusting the providers completely and stopped disclosing their health problems as they used to do before. Few providers also reported that the patients themselves limited their interaction with providers out of fear of getting COVID-19.

"The usual process of sitting next to the doctor and analyzing the conditions of the patients is not happening... Now they just have to go there, collect the tablets and leave the place. They don't have any freedom to talk to the doctor as they had done before or they can't even tell their own experiences. How could they be standing behind the ropes and shout out their experiences? They might feel bad right? It is very different when we talk next to the person and speak when compared to sending it through a middleman. Now even if they had white discharge they feel discomfort to say it out so they don't tell it." 34, Outreach Worker, TN

"The patients were scared and they wanted to leave as soon as possible by just wanting to take the medicines and go. They have the fear that looking at others and being with others, there is a possibility of catching COVID so the patients themselves were in a rush." 44, ART Nurse, TN

While providers resorted to community outreach or linking PLHIV with other centers, to ensure the availability of medicines, they faced a multitude of challenges that affected service delivery. Providers reported that fake credentials (name and address) provided by PLHIV made it difficult for the providers to identify the patients. There was also the constant worry of patient confidentiality getting breached by the presence of providers in the community. It was also reported by few respondents that the communities were not always in favor of outreach as they perceived the providers posed a far greater risk for them.

"When I went looking for a person, their name was registered as a female name; it was not the original name. So I tried to say other things to find him. Once I found his house I went and tried calling him but his phone was switched off. Later I gave the medicines to his cousin and informed him to call back once he gets back home. He conveyed thanks for the effort we put to give him the medicines. But it was really challenging for me because people gathered around when I went to his home and then I realized that I shouldn't do this and put their identity at risk." 50, ART Counselor, TN

"They also used to think that since we roam around a lot, what if they get infected from us? One group called me and asked, 'How

could you test other people, we should test you first' and asked me how could you come to our area like this?" - 42, NGO Staff, MH

Personal Challenges

This sub-theme discusses how the impact of the pandemic on the provider as an individual affected the provision of services.

Like any other section of the society, providers also reported challenges in traveling during the pandemic making it difficult for them to reach facilities. Some providers, especially women and those with special needs mentioned that this became particularly difficult when they were providing outreach. If they did not have their own vehicle, they had to depend on other modes of transportation, and most of the time it was not available, forcing them to walk long distances or settling to pay higher charges. Another major concern shared was their experiences of interacting with police. The majority of the providers mentioned that the police were not very cooperative which led to delay in field operations as well as some degree of fear, especially in women providers.

"...We faced a lot of issues during the lockdown. We had to explain to the police for 2–3 hours as to why we needed to go out and deliver these medicines and yet they were not convinced... It was very annoying" 42, ART Counsellor, MH

"*It was quite difficult for us to reach the center. I am an orthopedically handicapped person. It was tough for me to even get an auto at home. In addition to that, I had to pay much more for transport. But I still continued to serve." 49, Counselor, AP-TS*

Because of the priority given to COVID care during the pandemic situation, there was a sudden change in the routine of providers. Providers reported that they didn't perform the usual routine tests and limited their interaction with the patients because of the limited staff availability as well as the preventive protocols. Providers mentioned that not having enough staff didn't just add to their workload but also affected the quality of care and in turn affected their satisfaction.

"Right now we are on Covid duty. Initially, when we all were there it was easy to provide quality time for patients but now due to limited staff they can't be given more time and are sent back soon." 24, ART Counsellor, KR

"I felt bad about not doing tests. CD4 testing is necessary for issuing and dosage of drugs. We couldn't do it due to less staff. They took our lab technicians for COVID needs. Job satisfaction was lacking. So I did feel bad about it as it was a direct order from our superiors." ART Counselor,

Having to handle dual responsibilities of caring for their usual patients and managing COVID duty and battling the environmental challenges took a serious toll on the provider community. The majority of them mentioned that they were burnt out and exhausted at the end of the day. Moreover, wearing heavy gear PPEs, which is not something they are used to, also caused a great deal of physical discomfort for them. It was also reported by a few providers that there was a shortage of PPE in some locations which meant they kept reusing the same items again and again.

"It's the burnout which is happening because people are also tired of it. It's not that they don't care or they care less for PLHIV, but it's just that they cannot manage, they cannot do so much. They were overloaded with work, lots of patients coming with Covid, shortage of healthcare workers whether it is doctors, nurses, everybody was overburdened with work." 54, Primary care Physician, KR

"It is very difficult with masks because we are constantly wearing them. From the time we come in the morning to the time we leave, we are continuously wearing masks. I feel that we do not get enough oxygen also." 46, Staff Nurse, AP-TS

"We have to wear gloves to see them and examine them, we have to change them frequently but we had to manage with a pair of gloves for 3 days. We used to disinfect them and the next day also I used to wear the same gloves....Because for the first few months we didn't have a proper supply. Transport was not there. So, the hospital also had little supply." 47, ART Doctor, KR

Providers also mentioned that while they did all the good work, they didn't feel recognized or rewarded appropriately by the authorities. Many participants mentioned that on occasion they didn't even get their remuneration on time. The lack of any government support, discontinuance of previous provisions like travel allowance (TA), along with the additional expenditure to facilitate outreach made it extremely difficult for some of the providers to even afford their bare necessities.

"4 months have gone and now 5th month is going on, still, no payment has been done yet due to Covid only." 42, NGO Staff, MH

"Initially, even the front and second-line health workers were also provided TA but now it's completely stopped during this pandemic." 24, ART Counsellor, KR

"... We are not even being recognized properly... Despite performing such crucial roles, governments don't recognize our service and give the salary we deserve." 49, ICTC Counsellor, AP-TS

"Even in the PLHIV community, they're getting 2000–3000rs as a pension. Similarly, we also want such remuneration, madam. Please get us that. And we have very much difficulty in obtaining ration also since covid arrived." 45, Outreach Worker, KR

Many participants talked about their helplessness with the whole situation as they had no control over what was happening back then. Providers mentioned that they remember being in a quandary when they had to refer patients who became COVID positive to other facilities as they were not equipped to handle these cases. It was also discussed that they felt powerless over the outcomes and went into despair when they moved heaven and earth to ensure patients received care but still could not save them.

"We had to refuse a few referrals who came in a bad situation because we were not COVID authorized hospital and we couldn't know whether that person is COVID positive or not I know of one woman who we sent to Gandhi hospital referral from the place where she came and we came to know that she died. The whole organization felt very bad about that." - 50, Private Physician, AP-TS

"*It's just very disheartening because you're losing your own patient, somebody you have been managing. How much ever we try and say you know we should not sympathize or empathize, but at some point it gives pain. Why did you go that extra mile? Just imagine, everything you do to make the patient survive and you still lose the patient, it's terrible."* 54, Primary care Physician, KR

Finally and most importantly the providers mentioned that they were constantly worried about their susceptibility to COVID-19. While they performed their duty out of obligation and passion, they always had a fear of whether they were putting their loved ones or patients at risk of COVID-19.

"They would call me inside but the thought that comes to my mind would be I have to maintain distance from them because we are exposed to so many places and people like GH, so because of us what if they get infected!..... Or if I get it from them then I am putting my family at risk. Both the ways it is problematic." 34, Outreach Worker, TN

"And there is this thought about am I at risk, am I at risk, so it's anxiety. Until we reach our house, we cannot say that on the way who will have what, and whether we will possess the virus or what, we won't know. So, every time we have to be on the side of caution. In the house also we have to maintain social distancing with elders and children." 47, ART Doctor, KR

Remodeling Care Delivery to Ensure Continuity of Services

The second theme describes the adaptations to the existing HIV care delivery model as well as the novel strategies adopted by the providers to overcome the challenges experienced during the lockdown and ensure continuity of services.

The majority of the providers reported prioritizing an uninterrupted supply of ART medicines over physical consultations or in-patient visits at health facilities. Taking into account the difficulties PLHIV experienced in reaching health facilities due to financial difficulties and lack of transport as well as their susceptibility to increased risk for COVID-19, community dispensing was widely adopted. To this end, providers conducted extensive outreach, collaborated with local health facilities, NGOs, and other community organizations to provide services for PLHIV. Providers reported informing the PLHIV in advance and dispensing the medicines and supplies at a community outreach point that was comfortable for the patients. Providers have also reported that they made every effort to ensure confidentiality of the patients' identity and condition.

"Now patients are coming, but many of them could not come, then. Due to Covid, buses and all were stopped..., even if a patient came with their own vehicle, they would face problems. That is why we made a plan along with the NGOs and arranged for a truck... First we would do a follow-up on the phone and make a list of the medicine they needed, and a place would be decided. Then we would give them the information that we are giving drugs at this location, you can go there calmly and medicines will be given to you without any problems. Then, our truck would go there. It was like home delivery then sir." 46, Staff Nurse, AP-TS

The process of outreach was not just limited to dispensing of medicines, but also providing home visits to assess any illness as well as providing supportive care like counseling, etc. Wherever possible, providers also reported supplying communities with provisions and other supplies necessary for their basic sustenance too.

"The meds were supplied through the ART counsellors only, so they counsel them and then after proper education the PLHIV patients will be given the meds." 37, Program Manager, TN

"Most patients come to us with their problems as they have no work or no money during lockdown. We provided help through NGOs by giving them ration kits, coordinated with NGOs, ORWs, and ICTC care providers and provided medicines to patients' homes, who had difficulties to come to the ART centers." 24, ART counsellor, KR

Teleconsultation was another important service delivery adaptation reported by the majority of the respondents. This included reaching out to patients to provide a consultation for acute and chronic illness, psychosocial support as well as to facilitate appropriate care from nearby centers to which they were referred. In addition, providers also continued tracing of patients missing appointments or due for ART refill, etc. *via* phones instead of the usual physical follow-up.

"So, anybody who had the symptoms of fever, cough, cold we consulted over the telephone. On a video consultation, you can really see whether the patient is actually dyspneic or not, whether they need to be taken to a hospital or managed at home. So, we did manage quite a few patients over the tele-consultation but then slowly by the 2nd week of April, we started resuming our homecare" 54, Primary care physician, KR

"We provided our ART centre contact number to all the patients in their green books, so most patients themselves contacted us during emergency, if not at the end if any patients were left out to buy medicines, we contacted them. All the patients were referred to taluk hospitals for their convenience, very few patients could afford to come here, we treated them." 24, ART Counselor, KR

Where PLHIV were able to reach ART centers or other care facilities, providers encouraged community members to seek services directly from health facilities. It was also reported that providers reached out to patients to inform them in advance about the availability and duration of services. In addition to following recommended Infection Prevention and Control practices in the centers, providers adjusted the patient flow and limited the duration of interaction to avoid overcrowding and thereby limit exposure to patients as well as healthcare staff.

"Patients had a doubt whether the ART centers will be open or what, but we called them up and we have informed them that ART centers are not closed, you can come anytime before 5:00 o'clock and take the tablets." 47, ART Doctor, KR

"The hospital has taken care to screen all patients before they enter and to maintain the social distance. Once they are admitted, the organization has seen that not many people were exposed." 50, Private Practitioner, AP-TS

"Only critically ill patients were allowed inside the hospital to prevent exposure. Very few patients were treated during that time...Doctors treated patients in the same way they treated before COVID-19, they check patients and give them treatment but with precautionary measures" - 24, ART Counselor, KR

Resilience

The final theme details the different mechanisms identified and adopted by the providers to remain resilient in the face of the COVID-19 crisis.

Personal

This subtheme highlights the solutions the providers adopted, despite the multitude of service delivery and personal challenges they encountered while the coronavirus continued to spread.

Since they had no formal work policies which focused on their mental health, some providers took it upon themselves to reduce their stress levels and keep their emotional wellbeing in check. This was done by practicing meditation daily and holding frequent video calls between the team members to talk about work. Few providers also mentioned the support they received from their friends and family, how this developed their resilience and gave them the strength to keep working during this adversity.

"Everyone was doing meditation during the lockdown so that in this stressful situation we have 10 mins of meditation for mental peace. What used to happen was that you get irritated when another person or staff isn't able to understand me, so that meditation was really helpful in controlling tough situations." 42, NGO staff, MH

"I should also say that, I had strong support from my family - my husband and my kids. They knew the importance of my profession and supported me always." 46, Staff Nurse, KR

"Luckily our [supervisor] used to call us, and sessions were there to guide us and videos were exchanged between us so our stress was lowered." 42, NGO Staff, MH

Furthermore, since providers had a healthy and friendly relationship with their patients from the HIV community, having work satisfaction proved important for their psychological wellbeing. Some respondents from our study mentioned that getting the opportunity to work during the pandemic and help their communities made them happy and built their resilience. Providers also maintained constant communication with different health facilities and personnel working in the same field, so that they could coordinate and streamline service delivery, and thus keep themselves tension-free.

"Even though the work was more satisfying, the thing is that we could go serve them when PLHIV were not able to come and take their medicines. If you think it's a problem, it is a problem. If you don't think of it as a problem, it is not." 32, Nurse, AP-TS

"When I got Covid, the other staff nurse, the pharmacist and whoever was there on duty in that time, they coordinated among themselves and with the doctor also helping us, they followed instructions on what to do, and like that we made sure that services were delivered to the patients." 46, Nurse, AP-TS

Relationships With Community

Most of the providers mentioned that their own difficulties during this crisis only heightened their sense of responsibility and commitment to the communities they work with. Being mindful of their responsibility for the communities they serve helped the providers remain motivated and overcome the many struggles during the pandemic.

In addition to providing emotional support and management of health problems for PLHIV, the providers described further extending their services to ensure the basic needs of the community were met. To that end, providers offered financial assistance to PLHIV thus ensuring they had money to travel and seek care when needed; teamed up with local NGOs and support networks to ensure that basic provisions were made available for communities. Working extra hours, providing support using the remuneration they received, and reaching out to communities to ensure services are delivered even when they were not designated to do the same are all testimonials to how deeply the providers cared for the communities.

Providers also mentioned that the support and understanding gesture from communities, also helped them do their duties better and with much more motivation.

"Even if they leave for their villages, they stay connected to us via phones and we tell them when to visit the office, where to collect the medicines etc. We are doing all this using our own money. I am myself HIV positive and as I am going through this phase in life, I don't want others to suffer from this." 42, NGO Counsellor, MH

"I think it's our duty to take care of the patient and we have to adapt ourselves to the situation and we have to provide the basic things, some of them didn't have food to eat and they didn't have money to travel... Most of them were becoming unemployed during that time., so we used to deposit some amount in their accounts, and then they used to come and visit." 47, ART Doctor, KR

"I know that ART will be available to them. But before consuming ART one has to eat something so we mentioned their names as per priority in the grocery distribution list. I have arranged for this work beforehand only." 42, NGO Staff, MH

"I give them moral boosting to remain strong psychologically and rise up to the situations. I get calls till 10 pm at times. I have been counseling for 20 years and I dedicate my life for this purpose." 49, ICTC Counsellor, AP-TS

Collaborations With a Network of Providers

As the name suggests, the third sub-theme describes how the providers formed strong networks with the local providers to enhance their crisis response and continue service provision.

Even though the institutions that the providers in our study represent are self-sufficient in providing services for PLHIV, the challenges posed by the pandemic made it extremely difficult to continue care delivery. Study respondents mentioned that interdisciplinary collaboration is essential to provide quality care and efficient services. This led them to make quick adaptations to their service delivery methods as information regarding COVID-19 management evolved.

> *"In this situation of COVID, we try to deliver medicines at the doorstep of patients who do not have enough money or cannot travel to the center. We take help from NGOs, CBOs, TI, and VIHAN. This is a chain, where all have to work in coordination then only, we can see progress." 42, Counselor, MH*

It was reported that civil society organizations partnered with National AIDS control societies and programs and public health facilities joined forces with NGOs; to identify the beneficiaries, distribute medicines and provisions with the support of outreach workers (ORWs) as well as create awareness and communicate the availability of services.

> *"During the lockdown period, the patients could not come here at all. So, what we did was we made a micro plan with the Share India team, Naari Shakti, these NGOs. So we took the outreach workers and with a list of the patients and their medicines details, they went on a truck and did home delivery of medicines." 35, ART Doctor, AP-TS*

Providers also mentioned that because of these linkages, they were able to overcome the challenges due to the lack of transport facilities. Working side by side with local hospitals and health centers enabled providers to use institutional vehicles for conducting outreach. It was also discussed that informing the local government authorities about the nature of their job helped them procure permissions and travel passes which helped mitigate the troubles caused by interactions with police.

> *"We used the TANSACS hospital vehicle to supply the drugs to the center and ensured that it reached the PLHIV patients." 37, Program Staff, TN*

> *"Yes police stopped us at times but that was not a big problem as now we had our identity cards and official permission from government authorities as healthcare providers."* 49, Counsellor, AP-TS

Forming alliances with care providers at multiple levels ensured that there was no break in the provision of services. In addition to verifying whether patients were receiving care from tertiary hospitals and other primary health facilities locally, these coalitions also made it possible to deliver care to beneficiaries from other states as well.

> *"We made a list of patients who were at their native and also the list of contact details of centers at various locations and informed the centers. We informed the patients to collect medicines from wherever they are and asked them to inform us in case the centers didn't provide them medicines so that we can recommend them directly." 39, ART Nurse, KR*

DISCUSSION

This study explored healthcare provider experiences while providing HIV care during the first wave of COVID-19 in India. Our findings highlight the extensive obstacles that providers faced, despite which, they remained resilient and continued providing quality care to PLHIV by adopting novel and innovative strategies. The concept of assessing health systems from a resilience perspective is recent, where capacities of health actors and institutions are viewed from their ability to prepare, absorb and recover from unexpected and dynamic shocks and situations in the most equitable manner (17). Prevalent throughout the narrative of our study participants was a sense of responsibility and the need for coordinated efforts to ensure care is provided for the communities they serve. Our HIV care providers lent to situational resilience (18) by providing telephonic consultations, door-to-door delivery of medications, and collaborating with local NGOs and community organizations.

The respondents in our study faced several challenges-ranging from systemic, community-level, and personal, which resulted in high levels of stress and anxiety. These stresses need to be viewed in conjunction with the disease burden of COVID-19 in India and the capacity of the health system, to better understand the results. Although a few respondents mentioned the practice of meditation, seeking family support, and initiation of team-building activities in the workplace, our findings highlight the burden of mental health issues the providers in our study were facing and that none of them recognized the need to seek out help. To prevent burnout, an immense need exists for provider-supportive work environments and affordable formal mental healthcare services since previous studies reflect that such environments help exhibit greater resilience, including emotional regulation, self-efficacy, and adaptive coping strategies in providers. Being resilient psychologically and responding to situations appropriately is important for healthcare employees, especially when facing crisis situations like the COVID-19 pandemic. It also enables the providers to overcome the multitude of challenges as well as recover from the pandemic more easily (19).

Aside from workplace interventions, we believe that financial and personal security would also play a key role in lowering stress for providers and helping them provide quality care. Our study respondents reported that most of them were not given remuneration for their services for months, most did not receive transport allowance, and some did not even have adequate PPE to protect themselves from COVID-19. Socio-economic deprivation, such as this, can have a long-term impact on mental health and delay care-seeking among providers (20).

Health system financing has been a long-term cause for concern in India (21) and though the one-time support to communities and providers in the form of monetary relief and insurance support by the government is extremely important, it does not lend to structural impact on the health system efficiency and support (22). Long-term resilience needs to prioritize the economic security and social protection that are mindful of provider challenges.

Our study highlights areas of action that can be undertaken to provide and enhance systemic resilience for future resilience preparedness. While the providers could use their personal relationships and networks to build and provide to the continuum of care for PLHIV, a government led-multisectoral approach that includes all levels of stakeholders, including local authorities and communities (23) based on clear and coordinated SOPs is required for enhanced long-term management for emergencies. Further, bolstering public health capacity through an increase in the skilled and protected healthcare workforce and continual training support will provide strengthened linkages in the health system.

Our study comes at a time when it is imperative to realize the toll that COVID-19 is taking on our healthcare system and its repercussions among the provider community. The findings from our study are not unique, however, they highlight the long-standing problems of our health system that were exposed and severely compromised during COVID-19. What is unique, however, is the resiliency that was provided due to the initiatives taken by frontline workers to care for the most vulnerable. The strength of the findings lies in the adaptability and agile response that the providers were organically able to provide, which makes systemizing them a potential pandemic response. Despite our best efforts, our study has some limitations. Since the findings are self-reported, respondents may be influenced by the poor recall and social desirability bias. Further, the data we have is specific to five Indian states and is limited to experiences of providers catering to PLHIV during the first wave of COVID-19. Therefore, the findings may differ with geographies and the intensity of subsequent waves of the pandemic and may not capture systemic issues across the entire healthcare system. In addition, because of the ongoing restrictions like physical distancing and other infrastructural challenges, we conducted the interviews through the telephone; which may have resulted in the loss of a more nuanced interpretation of the findings from the body language of the participants, etc.

Even though the providers strived to remain resilient and continued providing quality care for PLHIV, the sudden change in the work culture and intensive work have drained health care providers emotionally and physically. It is important to conduct rigorous studies to understand the impact of the pandemic on the psychosocial wellbeing of healthcare providers, which will throw light on the role of regulators like resilience etc. Government should also take a holistic approach to safeguard the wellbeing of providers and invest in efficient systems and disaster preparedness to manage any future crises.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Catalysts Group Institutional Review Board. Verbal consent was sought from all participants in the study in accordance with the national legislation and institutional requirements.

AUTHOR CONTRIBUTIONS

NP, SB, and PS wrote the first draft of the manuscript. AC critiqued the final version. All authors contributed to the study conception and design, material preparation, data collection and analysis, commented on the latter versions of the manuscript, and read and approved it.

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Utilizing Causal Loop Diagramming to Explore a Research and Evaluation Capacity Building Partnership

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The capacity to engage in research, evaluation and evidence-informed decision-making supports effective public health policy and practice. Little is known about partnership-based approaches that aim to build capacity across a system or how to evaluate them. This study examines the impacts of a research and evaluation capacity building partnership called the Western Australian Sexual Health and Blood-borne Virus Applied Research and Evaluation Network (hereafter, SiREN). SiREN aims to strengthen capacity across a system of clinical and medical services and government and non-government organizations. These organizations are connected through their shared aim of preventing and managing sexually transmissible infections and blood-borne viruses. To examine SiREN, systems concepts and methods were used. Data were collected from SiREN organizational documents (n = 42), a survey tool (n = 104), in-depth interviews (n = 17), a workshop and three meetings with SiREN stakeholders and used to develop two causal loop diagrams. Findings show engagement with SiREN was influenced by a complex interplay of contextual (e.g., organizational capacity) and process (e.g., presence of trusting relationships) factors. SiREN contributed to system level changes, including increased resources for research and evaluation, the development of networks and partnerships that led to more efficient responses to emerging health issues, evidence sharing, and sustainable research and evaluation practice. The use of causal loop diagrams enabled the identification of key leverage points that SiREN can use for continuous improvement or evaluation. The focus on how contextual factors influenced SiREN's ability to create change provides valuable information for researchers, policymakers or practitioners seeking to develop a similar partnership.

Keywords: partnership, public health, research capacity, evaluation capacity, evidence-informed decision-making, systems thinking, causal loop diagram

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INTRODUCTION

The capacity to engage in research, evaluation and evidence-informed decision-making supports effective public health policy and practice (1). Research and evaluation capacity building can be collectively defined as the intentional process of improving the motivation, knowledge, skills, and structures to engage in sustainable research and evaluation practice and

apply research and evaluation evidence to decision-making (2–4). Evidence is acquired from multiple sources in public health, including research, evaluation, professional experience, surveillance data, and community perspectives, and then synthesized to guide decision making (5, 6). Capacity building can be theorized as a catalyst that releases potential from within individuals and organizations (7). For capacity building to be effective, it requires those involved to see the benefit and be committed to the process (7, 8). Strategies to build research, evaluation, and evidence-informed decision-making capacity in public health can target the individual, organization or system level. These strategies include training, tailored support, partnerships between researchers and decision-makers, the provision of resources (e.g., funding) and the development of infrastructure (e.g., research practice networks) (1–3, 9). Despite investment in capacity building strategies (7, 9, 10), little is known about developing and implementing them in different contexts, the kinds of impacts and outcomes they can achieve and the mechanisms by which change is achieved (7, 9, 11–14). A systems approach has been identified as a means to enhance understanding of capacity building initiatives (15). This paper describes a study using a systems approach to examine a research and evaluation capacity building project and inform its evaluation.

The capacity building project examined in this paper is called the Western Australian Sexual Health and Blood-borne Virus Applied Research and Evaluation Network (hereafter, SiREN). SiREN is a long-term partnership between sexual health and blood-borne virus (SHBBV) researchers, service providers and policymakers in Western Australia (WA) formally established in 2012 to strengthen evidence-informed policy and practice within the SHBBV sector in WA by developing research and evaluation capacity. A team of senior researchers coordinates SiREN within a large, global and highly ranked university (16). In Australia, the large majority of SHBBV research is generated by national centers located on the east coast and does not always address the specific SHBBV issues relevant to WA. The epidemiology of sexually transmissible infections (STIs) and blood-borne viruses (BBVs) in WA differs when compared to other parts of Australia (17, 18). This is in part due to the large land area, geographical isolation and differences in demographics. These factors have impacted on the availability of local SHBBV evidence for use by public health professionals. Compounding this, a recent survey of SiREN's stakeholders (individuals and organizations working to address SHBBVs) identified a perceived lack of research and evaluation capacity and insufficient access to relevant research as barriers to engaging in research, evaluation and evidence-informed decision-making (19). In response to WA specific needs, SiREN seeks to build stakeholder capacity to engage in research and evaluation and to build an evidence base relevant to WA SHBBV issues.

SiREN is embedded in a complex system composed of universities, clinical and medical services, and government and non-government organizations working toward the shared aim of preventing and managing STIs and BBVs in WA. The workforce composition is diverse and includes those in clinical, health promotion, peer-support, education, policymaking, and research-based positions. The system structure, activities and stakeholders constantly change in response to the social and political climate, variations in epidemiology, and developments in prevention and treatments (20, 21). The system is conceptualized as complex as it is composed of many interacting elements (individuals, organizations, relationships) that are dynamic and adapting, often in unpredictable ways (22, 23). SiREN can be considered as a series of ongoing events within the system that aims to influence the behavior and structure of the system, e.g., relationships, resources (24). SiREN aims to create change within the system through multiple strategies that include: delivering personalized research and evaluation support; providing tools, resources and evidence to guide program planning, research and evaluation; hosting a biennial research symposium; seeking grant funding; undertaking collaborative applied research and evaluation projects; facilitating and participating in research collaborations; and sharing the latest evidence, news and events with a network of over 430 individuals. The size of SiREN limits the scale of change; currently, it employs 1.4 full-time equivalent (FTE) staff as part of core funding and a further 4.0 FTE staff through additional grants. Additional descriptions of SiREN are available in previous publications (25–27).

Taking this complexity into account, a systems approach was employed in this research. Systems approaches are particularly suited to examining capacity building programs, like SiREN, that aim to create change across a system (15). This approach can also support the identification of indicators for ongoing monitoring and evaluation purposes (21). A systems approach can be used to understand a program by exploring the context in which it is implemented, the relationships between program and system elements, and patterns of change that occur over time (28, 29). Using such an approach can provide insight into how SiREN reshapes the system in beneficial ways including developing new capabilities, relationships and structures (28, 30). This study utilized causal loop diagrams, a type of qualitative systems modeling method that originated in the field of system dynamics (31, 32). This method uses word and arrow diagrams to visually represent stakeholder perspectives of the functioning of a system or program (33). They include feedback loops which are circular relationships between variables that can reinforce or balance change. Causal loop diagrams can provide insight into factors that influence a program's effectiveness and the kinds of changes it can achieve (34, 35).

While a solid evidence base supports partnerships and capacity building programs (4, 13, 36), little is known about how and in what ways they contribute to change (4, 36). Systems approaches to evaluation provide insight into the mechanisms of action and the identification of leverage points. These are crucial points within the system that can be influenced to effect change, enhance a program's effectiveness, and be used for monitoring and evaluation purposes (21, 37, 38). This study aimed to use systems concepts and methods to explore perceptions of (1) factors that influence engagement with SiREN, (2) the impacts and outcomes achieved by SiREN and the interactions between them, and (3) the use of causal loop diagrams as a method to understand SiREN and inform evaluation.

MATERIALS AND METHODS

This mixed-methods study used causal loop diagrams to examine factors that influence engagement with SiREN and the subsequent impacts and outcomes that occurred. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist (39) guided reporting. Ethical approval was obtained for the study (approval number: HRE2017-0090). Informed consent was obtained from all subjects involved in the study. This study forms part of a larger project described in a previously published study protocol (26).

Theoretical Framework

This research investigated how SiREN interacted with the system in which it is embedded and the impacts and outcomes that were achieved. Several different but overlapping areas of systems thinking were used (32, 40–42). Consistent with Checkland (39), the research study viewed a system as a mental model, built through drawing on multiple perspectives to facilitate understanding of the system. The study design used three principles from across the diverse field of systems methodologies and methods (40, 43), boundaries, perspectives and relationships. Boundaries determine what lies inside and outside a system (44) and are used to focus the inquiry (40, 44). In this study, the bounded system was the SHBBV virus prevention and management system, including SiREN and other organizations working to address SHBBVs in WA. Perspectives reflect an individual's point of view (40). The principle of perspectives acknowledges the plurality of views held by system stakeholders. Therefore, to enable a complete understanding of the system, multiple perspectives should be included (37, 45). In this study, a diverse range of views was sought along the spectrum of engagement with SiREN. Relationships are defined as causal connections between parts of a system (40). The principle of relationships focuses on how system variables interact and influence each other to achieve a purpose (46).

In this paper, relationships were explicated through causal loop diagrams (described above). This method is useful to describe how a program functions within the system it operates and enables program evaluation to move beyond individual project strategies to a more systemic view of changes over time (47, 48). Causal loop diagrams can act as a complexity sensitive theory of change (49–51). Causal loop diagrams have been used in other studies seeking to understand public health programs including prevention marketing (51), policy adoption (52), peer-based programs (21) and obesity prevention (35). However, they have not been used to evaluate a research or evaluation capacity building program (33). To date, the majority of studies exploring research and evaluation capacity building projects have applied more traditional approaches such as case studies and action research (8, 12, 53, 54). Lawrenz et al. (55) and Grack Nelson et al. (15) applied a complex adaptive systems lens to explore evaluation capacity building within a network. Other studies have applied a realist approach to research capacity building (7, 56). Cooke et al. (7) and Lawrenz et al. (55) concluded that complexity sensitive methods provide insight into how, and in what contexts, capacity building interventions work.

Research Team and Reflexivity

During the time this study was undertaken, four research team members (RT, RL, JH, and GC) were employed by SiREN or members of the SiREN management team. The SiREN management team consists of five university-based staff with experience working in research, government, and policy involved in SiREN 's operational and strategic management. The research team had extensive experience in public health, qualitative research evaluation, and capacity building. All members of the team have experience working with, or within, community-based blood-borne virus organizations.

Most research team members are considered insider researchers (RT, RL, GC, JH) (57), with implications for data collection and analysis. In other ways they can be considered outsiders, e.g., they have not received support from, or partnered with, SiREN, and they are not currently working in a government or non-government organization. Insider researchers bring with them knowledge of the research problem and access to participants (58). In contrast, outsider researchers may notice aspects of the data that an insider may overlook as they appear ordinary to them (59–61). Researchers used a reflexive approach during data collection and analysis to identify and address bias, including regular meetings with the research team and reflective journaling (62). To validate findings, participants were invited to participate in a workshop to refine the study findings.

Data Collection

Data were collected from SiREN organizational documents ($n = 42$) created between 2012 and 2020, a survey tool ($n = 104$) and in-depth interviews ($n = 17$) and used to inform the development of a draft causal loop diagram. Subsequently, the causal loop diagram was refined through a face-to-face workshop and three meetings with SiREN stakeholders ($n = 4$).

SiREN Organizational Documents

The following SiREN organizational documents ($n = 42$) were examined: biannual reports of activities and outputs ($n = 18$), reports evaluating SiREN activities ($n = 6$), needs assessment reports ($n = 3$), stakeholder emails describing impacts or outcomes of SiREN ($n = 3$), and stakeholder meeting minutes ($n = 12$). These documents provided an understanding of SiREN's activities, processes, impacts and outcomes.

Survey Tool

Every two years, the SiREN network is invited to participate in a needs assessment to inform SiREN activities and resource development. The SiREN network is a database of individuals across Australia with interest in SHBBVs. Summaries of relevant research and evaluation evidence, news, funding opportunities, and events are distributed *via* electronic mail. For this study, items were added to the needs assessment, and existing items were refined, using previous research and questionnaires (63–67). The survey tool was designed using Qualtrics survey-building software (68) and refined in consultation with three research team members (RT, GC, and RL). The final survey contained a combination of 43 open and closed questions, including factors that influence research, evaluation, and evidence-informed

decision-making practices, details of engagement with SiREN, and the influence engagement had on practice. The survey was estimated to take 15 min. The survey was published as part of the study protocol (26). A link to the survey was emailed to WA-based SiREN network members ($n = 204$); just over 50% ($n = 104$) responded.

In-depth Interviews

In-depth, semi-structured, qualitative interviews were undertaken with SiREN partners and service users ($n = 17$), purposively selected stakeholders based on engagement with SiREN in the past 2 years. SiREN partner engagement was defined as one or more of the following: worked in partnership with SiREN to undertake a research or evaluation project; applied for research or evaluation funding with SiREN; or took part in the SiREN steering group. Participants were selected across different levels of engagement, including those who had engaged once to multiple times. The steering group is composed of key SiREN stakeholders from WA non-government organizations, government organizations, hospitals and research organizations who provide input into the strategic management of SiREN. Service user engagement was defined as having received tailored project planning, evaluation or research support, e.g., developing an evaluation framework. Participants were predominantly from WA-based government, non-government and research organizations, with the exception of one interstate research organization. Employment roles included managers, educators, project officers, clinical trainers, and researchers.

Interviews sought to explore participant experiences of engaging in research, evaluation and evidence-informed decision-making within the system and engagement with SiREN. The interview guide [see the published study protocol (26)] was developed in consultation with the research team (RT, RL, JH, and BM) and pilot tested with a SiREN staff member. Questions examined the contextual factors influencing research, evaluation and evidence-informed decision-making practices, details of engagement with SiREN, and how and in what ways engagement with SiREN influenced practice.

Twenty-two individuals were invited *via* email to participate. Three did not respond to the invitation and two declined citing conflict of interest as SiREN's main funder employed them. Face-to-face interviews were undertaken with metropolitan participants at their workplace and *via* telephone with regional and interstate participants. The duration of the interviews ranged from 30 to 90 min. Interviews were digitally recorded, transcribed verbatim and reviewed for accuracy by RT. Transcripts were not member checked.

Draft Causal Loop Diagram Development

To develop the causal loop diagram, data from organizational documents, surveys and interviews were open-coded using NVivo 11 software (69) by RT similar to the grounded theory-informed approach recommended by Kim and Andersen (70). Coding was guided by the areas addressed in survey and interview questions including contextual factors that influence research, evaluation, and evidence-informed decision-making practices, factors that affect engagement with SiREN, and outcomes achieved by SiREN. Data were coded into categories until no new variables were identified and superordinate categories emerged. The second phase of coding identified system variables, causal relationships, feedback loops and time lags to inform the structure of the causal loop diagram. As part of this process, emerging variables and relationships were discussed and refined in consultation with members of the research team (RT, RL, JH, BM).

To link the causal loop diagram variables and relationships to their data source, a reference table modified from Kim and Andersen (70) was created using Microsoft Excel (Version 2105). This table included all variables, their relationships and supporting data. An example is provided in **Table 1**.

Identified variables and their relationships were transformed into a causal loop diagram using Vensim (71), a software program used for creating and presenting causal loop diagrams. The process of data collection, analysis and diagram building occurred concurrently.

Validating the Causal Loop Diagram

A 2-h workshop was held to validate the causal loop diagram. Participatory processes strengthens the validity of the causal loop diagrams and was used in similar studies (34, 72). In-depth interview participants ($n = 17$) and SiREN management team members ($n = 5$) were invited by email to participate. Workshop participants included in-depth interview participants ($n = 5$), SiREN management team ($n = 3$) and an observer from the research team (BM).

The workshop was facilitated by a researcher (RT). In the workshop, the facilitator provided a brief overview of systems thinking, guidance on how to interpret causal loop diagrams and a description of the diagram. Questions were then posed to the group including: if the diagram reflected their experience of SiREN, if there were any aspects not represented and if they had any comments on the terms used to describe the variables. Participants were seated around a square table, and in the center of the table was a laminated copy of the diagram (A0 size) and whiteboard markers. This format enabled the alteration of the variables and relationships as the group discussed them. The role of the management team in the validation process was not to provide their perception of the changes that SiREN had achieved but to support the interrogation of the diagram by asking questions, for example, seeking clarification on the meaning of variables and the nature of the relationships between them.

Following the workshop, three meetings of 30–60 min were held. Two meetings were held with individual members of the management team who could not attend the workshop and a meeting with members of the research team ($n = 4$) to refine the diagram. RT further developed diagrams in consultation with the research team to ensure they were able to be easily interpreted in published form and when the process of writing revealed new relationships and variables. One of these changes involved splitting the diagram into two, leaving the central variable of engagement with SiREN in both diagrams. This enabled the processes that influence engagement and the subsequent impacts and outcomes that occur to be clearly depicted.

TABLE 1 | Coding table example.

Variable	Effect variable	Relationship type	Supporting data and source
Trust built	Engagement with SiREN	Positive	*(SiREN's) got a nice connection with NGOs (non-government organizations), and I think there's a lot of trust between NGOs and the Government Department of Health with SiREN. And I think that helps facilitate it (engagement) as well.* Source: Interview (P14).

RESULTS

Two causal loop diagrams illustrate 1. factors affecting engagement and 2. impacts and outcomes. Diagrams are presented, followed by a table that describes the corresponding variables in alphabetical order. An explanatory narrative supports the diagrams and table, and deidentified participant quotes illustrate findings. The narrative discusses diagram variables and relationships under related topic headings.

To read the diagrams, select a variable of interest and follow the causal connections. Relationships between variables are either positive (represented as "+") or negative (represented with "–"). The system variables and relationships join to form feedback loops. Feedback loops illustrate circular cause and effect relationships that can be reinforcing where they amplify change (represented with an "R") or balancing where they attenuate change by driving change in the opposite direction from where it started (represented with "B") (48). Time delays (represented by a "//") occur where there is a delay in a change occurring (48).

Engagement

Analysis identified two types of engagement, transactional and synergistic. These are important determinants of the kinds of impacts and outcomes that were achieved. Transactional engagement was identified as brief, addressing a specific question within one or two interactions with SiREN. Examples of transactional engagement included support for writing a conference abstract or refining an existing evaluation tool. Transactional engagement led to increased research and evaluation confidence, knowledge and skills. Synergistic engagement was identified as occurring over multiple interactions with SiREN across an extended period of time, (e.g., months, years) and led to the development of trusting relationships. It involved both parties combining their knowledge to address research and evaluation issues, such as developing a program evaluation plan or research proposal and had the potential to lead to all identified impacts and outcomes.

The first causal loop diagram (**Figure 1**) illustrates factors that influenced engagement with SiREN. Diagram variables are defined in **Table 2**. The diagram indicates that engagement with SiREN is dynamic and changed in response to factors within the control, (e.g., presence of trusting relationships) and outside SiREN's control, (e.g., organizational evaluation capacity).

Existing Relationships Act as a Springboard

The presence of a *collaborative culture* within the system increased engagement with SiREN. This culture predated SiREN and was traced back by interview participants to Australia's partnership-based response to the HIV epidemic (75). Participants reported that this legacy of collaborative working continues to influence how connected they are. In addition, the SiREN management team had a decades-long history of working with, and within, government and non-government organizations. The relationships formed during this time included those of research partners, colleagues, and friends. These relationships acted as a springboard to generate awareness of SiREN, support its credibility, and develop the partnerships and networks that underpin its approach:

> *(SiREN is) a reliable source of support, it comes from the SiREN team as I said, I suppose, being embedded within (the University), those past relationships that I, we, the sector has had with (the University) over many, many years. (P10)*

Support From Funders

The funding environment had a dual effect on engagement. On the one hand, *funding policy* increased engagement as the main funding body encourages funded organizations to actively work with research-based organizations, like SiREN, for research and evaluation purposes. On the other hand, the main funding body recently transitioned its funding model from a preferred service provider status to a *competitive tendering process*. This model resulted in some organizations competing with one another for funding. Participants suggested this transition had a detrimental effect on the *collaborative culture* and resulted in a lack of clarity regarding whether SiREN could be trusted to provide confidential support to all applicants for competitive funding.

Perceptions of SiREN

Engagement increased when stakeholders perceived SiREN to be trustworthy and credible. Credibility was enhanced by SiREN's association with the University, which gave SiREN source credibility (76) and its relationships to other organizations working within the system which provided credibility by association (77). Other factors that enhanced perceived credibility included the visibility of SiREN, (e.g., presentations at events and publications) and the view that SiREN is a "storehouse" of knowledge for the sector:

> *I think it was the backing of a university… that I think makes (SiREN) a really credible source for that type of advice… it's SiREN acting as more of the point of contact for lots of other organizations that may have contacted them for the same thing. (P4)*

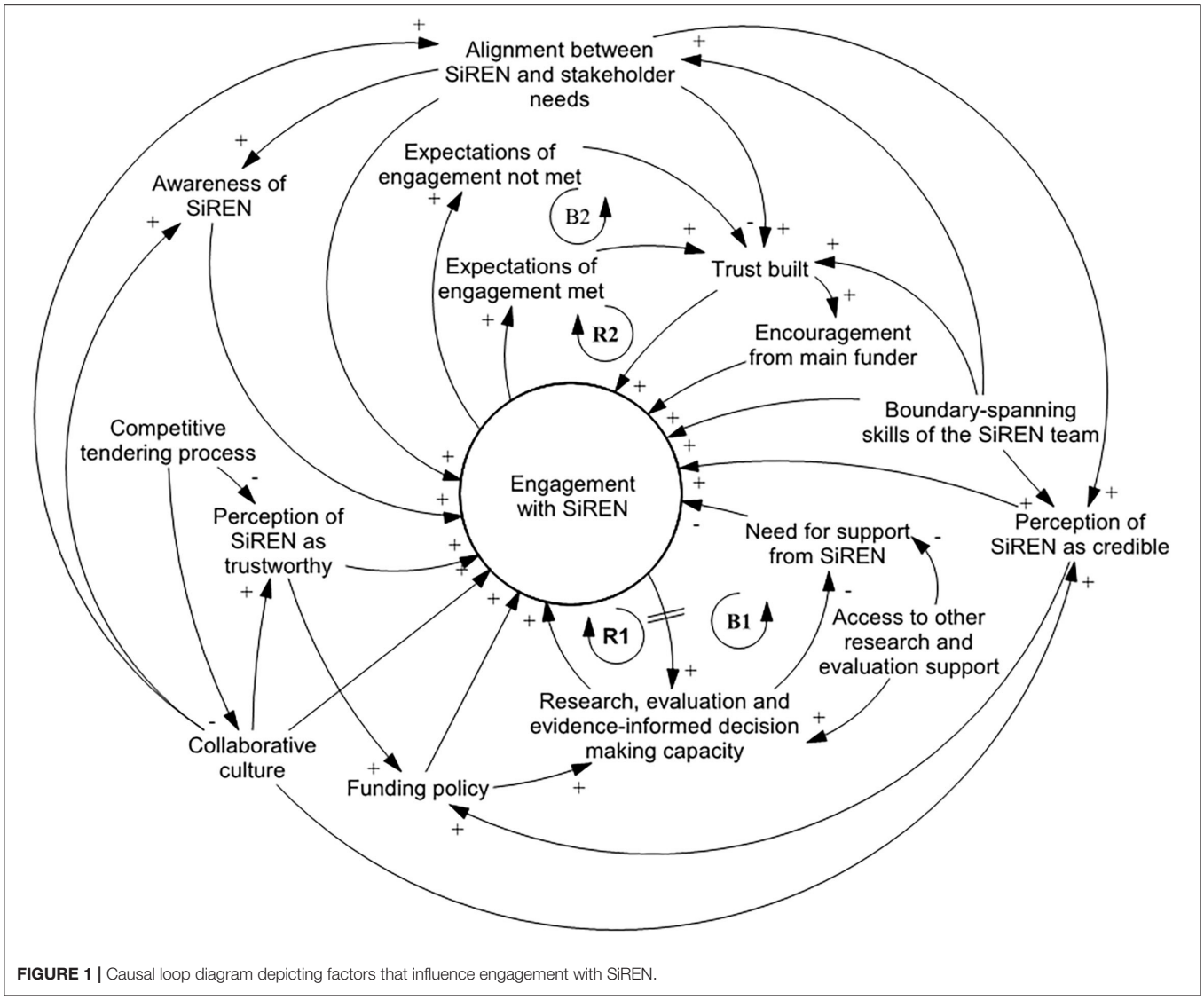

FIGURE 1 | Causal loop diagram depicting factors that influence engagement with SiREN.

The Relationship Between Capacity and Need for Support

Research and evaluation capacity and *the need for research and evaluation support* was dynamic and varied across the system. Participants identified a range of factors that influenced their capacity to engage in research and evaluation including: level of knowledge and skills, attitudes and values, accessibility of target groups and data, access to resources, (e.g., funding and time), requirements of funding bodies, and the availability of internal and external research and evaluation support. Participants required the capacity to engage in research and evaluation to engage with SiREN, e.g., through time or support from management. Engaging with SiREN increased *research and evaluation capacity*. In some cases, this boosted *engagement with SiREN* as awareness of, and ability to, engage in new research and evaluation opportunities (e.g., developing new evaluation methods, research projects) increased [**Figure 1**, reinforcing loop 1 (R1)]. This was explained by a service user who had recently commenced a research project in partnership with SiREN:

> *(SiREN team member has) been encouraging me to find these sort of research projects, you know, and so I'm starting to kind of now see opportunities which is great… and I know that when I take that step I'll have the support I need. (P6)*

However, when *research and evaluation capacity* increased due to receiving support from SiREN, it could also lead to a decrease in engagement. This is because the need for *research and evaluation support* decreased, leading to a reduction in *engagement with SiREN* as service users felt they had the resources and skills to meet the requirements of their role [**Figure 1**, Balancing loop 1 (B1)]. A non-government organization staff member reflected on why they had not engaged

TABLE 2 | A description of variables that influence engagement with SiREN.

Variable	Description
Access to other research and evaluation support	Support available beyond the support provided by SiREN, e.g., relationships with other research centers.
Alignment between SiREN and stakeholder needs	SiREN's services were compatible with the research, evaluation, and evidence-informed decision-making needs of stakeholders.
Awareness of SiREN	Stakeholders understood what SiREN is and the kinds of services and support it can offer.
Boundary-spanning skills of the SiREN team	Ability to build relationships and facilitate learning across diverse groups (73), e.g., research and service delivery.
Collaborative culture	Stakeholders had a history of working together, as well as with SiREN team members, to address SHBBV issues.
Competitive tendering process	Organizations needed to compete for funding from the main funding body.
Encouragement from main funder	The main funder encouraged funded organizations to engage with SiREN when they require research and evaluation support.
Engagement with SiREN	Occurred when a partner or service user participated in a SiREN advisory group; partnered with SiREN to undertake research, evaluation or apply for a grant; or received program planning, research, evaluation, or evidence-informed decision-making support.
Expectations of engagement met	When SiREN met partner or service user expectations of what SiREN will do, e.g., develop an evaluation tool.
Expectations of engagement not met	When SiREN did not meet partner or service user expectations of what SiREN will do.
Funding policy	The main funding body stipulated that some funded organizations must engage with research organizations for research and evaluation purposes. Funded programs were contractually obligated to be evaluated.
Need for support from SiREN	The need for support from SiREN arose when an individuals or organization's capacity did not meet their requirements of their role.
Perception of SiREN as credible	Stakeholders perceive the information provided by SiREN as reliable.
Perception of SiREN as trustworthy	Stakeholders felt that information shared with SiREN will be kept confidential. This view can be held because of an interaction with SiREN or because of SiREN's reputation.
Research, evaluation and evidence-informed decision-making capacity	The motivation, knowledge, skills, and resources to undertake research and evaluation and apply evidence to decision-making (2–4).
Trust built	Developed through repeated interactions over time. Trust enabled partners and service users to know SiREN will act in a trustworthy way (74).

with SiREN since receiving support to develop a logic model program plan:

> *I've been able to keep the ball rolling and rather confidently go through my project... Knowing I'm doing the right thing that I'm supposed to be doing in exactly the right way, with the knowledge I'm supposed to have that's up to date. (P5)*

Need for support from SiREN also decreased when participants had *access to other research and evaluation support,* e.g., a new research officer working within their organization.

The Effect of Trust

When trusting relationships were built between SiREN and its partners or service users, it increased engagement [**Figure 1**, reinforcing loop 2 (R2)]. Because of the reinforcing effect between trust and engagement, there was increased potential for impacts and outcomes. Trust was identified in analysis as a leverage point due to its central role in strengthening relationships and its potential to enhance the impacts of SiREN. The development of trust was a social process whereby partners and service users learn through experience that SiREN will act reliably (74):

> *I think it's about showing credibility, following through with promises. So, saying they'll do something and actually doing it. (P9)*

As highlighted in the quote, credibility, integrity, capability, and meeting expectations were important components of trust related to SiREN. Trust was dynamic and could be affected. For example, as reflected in Balancing Loop 2 (**Figure 1**, B2), one participant reported that their *expectations of engagement were not met.* In this instance, engagement decreased but did not cease indicating that *trust* was reduced but not lost.

Positioning of SiREN

Another leverage point was the *boundary-spanning skills of the SiREN team which* boosted engagement. These qualities were attributed, in part, to the past and current experience of the team working across research, clinical, government and non-government organizations. These experiences furnished team members with an understanding of how to undertake and support research and evaluation in policymaking and service delivery contexts and how to communicate with diverse groups of people. Participants described these qualities as being approachable, understanding, having expertise, and supporting the exchange of knowledge:

> (*SiREN Team Member was) so forthcoming and it was so quick for her to identify where I was at and was easy for me to understand where she's at, that compatibility of how we could share knowledge. (P12)*

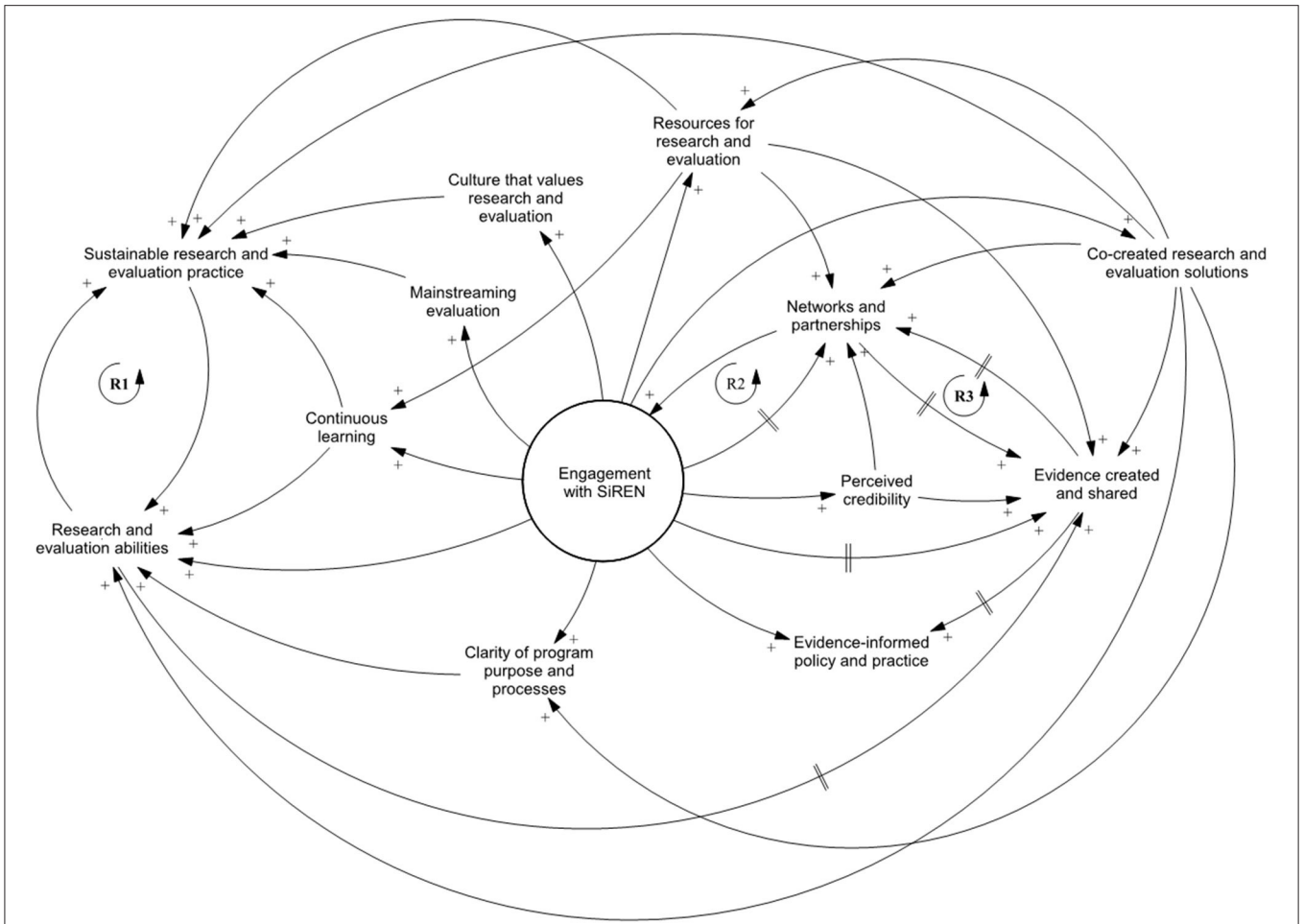

FIGURE 2 | Causal loop diagram of impacts and outcomes.

The boundary-spanning skills of the SiREN team facilitated *alignment between SiREN activities and stakeholder needs.* Boundary-spanning skills supported the transfer of knowledge (78) from stakeholders to SiREN. SiREN subsequently used this knowledge used to align its services to their research and evaluation needs. The alignment process was aided by SiREN's governance structure, as both the management team and steering group members contributed their understanding of the system into decisions of how SiREN delivered its services. Other processes that increased *alignment between SiREN and stakeholder needs* included a biennial stakeholder needs assessment and a research priority-setting process. The needs assessment sought to understand the research and evaluation needs of stakeholders to inform SiREN activities. The research priority-setting process involved working with the sector to establish key research priority areas and support the development of collaborative research grant applications to address agreed topics. SiREN also informally exchanged knowledge with stakeholders at meetings and events which informed alignment. Alignment strengthened *trust* between SiREN and its partners and service users and provided SiREN with the insight required to develop solutions to research and evaluation challenges:

> *I do feel that the sector has grown. I feel that SiREN's grown, and I think they've actually grown together… (SiREN) understanding the sector more, and the challenges that come, but also having some great ideas on ways to deal with those challenges as well. (P9)*

Impacts and Outcomes

The second causal loop diagram (**Figure 2**) explores the impacts and outcomes that have resulted from engagement between SiREN, its partners and service users. The diagram shows that an occurrence of an impact or outcome does not mean an end point has been reached; rather it is feedback into the system as an input and continues to create change. The variables for this diagram are defined in **Table 3**.

Impacts are defined as short-term changes that generally occur before outcomes, such as increased research and evaluation confidence, knowledge and skills. Outcomes are longer-term changes, an example being the application of evidence to policy and practice decision-making (80).

Clarity, Ability and Credibility

When SiREN provided program planning and evaluation support, a logic model program plan was often developed that

TABLE 3 | A description of impact and outcome variables.

Variable	Description
Clarity of program purpose and processes	Understanding what a program is aiming to achieve, how it will achieve it, and how it fits within the broader SHBBV prevention and management system.
Co-created research and evaluation solutions	SiREN, its partners and/or service users combined knowledge to co-create research and evaluation solutions, e.g., evaluation method or a research grant application.
Continuous learning	SiREN provided a range of opportunities to engage in ongoing learning, e.g., workshops, online resources, post graduate research.
Culture that values research and evaluation	Value the contribution that research and evaluation makes to their practice and is open to participating in new research and evaluation opportunities.
Engagement with SiREN	Engagement occurred when a SiREN partner or service user participated in a SiREN advisory group; partnered with SiREN to undertake research, evaluation or apply for a grant; or received program planning, evaluation or research support.
Evidence created and shared	SiREN worked collaboratively to create and share an evidence base that is relevant to local issues, e.g., journal article or report.
Evidence-informed policy and practice	Involves combining the best available evidence from research and evaluation, experiential knowledge and contextual factors to inform decision-making (5).
Mainstreaming evaluation	Integrating evaluation as part of routine practice (79), e.g., the development of evaluation plans.
Networks and partnerships	Formal and informal relationships between researchers (including SiREN), service providers and/or government to create and share evidence and knowledge.
Perceived credibility	Perceived the credibility of the evidence created or their program and/or organization increased after receiving support from SiREN.
Research and evaluation abilities	The confidence, knowledge and skills to undertake research and evaluation and apply evidence to decision-making.
Resources for research and evaluation	Resources included financial and human resources, e.g., research grant funding or opportunities for postgraduate research students.
Sustainable research and evaluation practice	Research and evaluation capacity is maintained or increased over an extended period.

outlined objectives, strategies, and evaluation measures. Several participants explained the process of creating this plan increased clarity around their program:

> *That was the biggest thing that I got out of it (working with SiREN), was having that really clear understanding of this is exactly what I'm trying to do, and this is how I need to do it. (P5)*

Engagement with SiREN and *clarity of program purpose and processes* increased *research and evaluation abilities* at an individual level. Some participants described losing confidence in their evaluation skills in their initial engagement with SiREN as they developed more comprehensive knowledge and capability. The ongoing and flexible support provided by SiREN provided individuals with an opportunity to engage in *continuous learning*. This iterative, action-oriented process of learning and doing while supported by SiREN, enabled participants to put new knowledge and skills into practice and re-build their confidence:

> *I had thought that I had a handle on exactly what I was trying to achieve in my project at that particular time and how I would measure it. It wasn't until I went through this formal process of having to strip it back, that I realised that maybe I didn't quite have the handle that I thought I had. (P5)*

Several participants reported that engaging with SiREN increased the credibility of their program and research or evaluation findings. This increased confidence to share their work at conferences and events and work in partnership with other organizations.

Building Sustainable Research and Evaluation Practice

SiREN contributed to building *sustainable research and evaluation practices* by increasing r*esearch and evaluation abilities* [**Figure 2**, reinforcing loop 1 (R1)]. As abilities developed, individuals and organizations were more likely to engage in research and evaluation activities, thus increasing research and evaluation practice sustainability. SiREN has also supported *sustainable research and evaluation practices* by developing a *culture that values research and evaluation*. Participants spoke about how they placed more value on evaluation and research due to engaging with SiREN. One participant reflected on how they now felt comfortable taking risks, e.g., pursuing a new research project, knowing they had the support of SiREN. This growth in research and evaluation culture built sustainability by increasing research and evaluation activity as service users saw the benefits it brought to their work:

> *It's not something you just tag on the end of something. I've learned a lot about the importance of evaluation... now I want to spend more time on evaluation... But it's not because I have to do it, it's because I need to do it. Because at the end of the day, that's so important for funding... I can see the impact that this training could really have if I evaluate it properly.* (P11)

SiREN has also supported *sustainable research and evaluation practice* by working with individuals and organizations to develop logic model program plans that contributed to *mainstreaming evaluation* in their organizations. Furthermore, it provided *continuous learning opportunities* such as the supervision of postgraduate research students; the provision of online resources such as evaluation toolkits; and the delivery of personalized research and evaluation support. These changes begin at the individual level. Over a period of several years, SiREN has been able to build capacity within multiple organizations leading to these changes being evident across the system. However, the dynamic nature of the system, e.g., funding and staffing changes, can disrupt this.

Relationships and the Co-creation and Sharing of Evidence

SiREN worked with its partners and service users to *co-create research and evaluation solutions*. These solutions included creating evaluation plans, designing evaluation tools, and developing research grant applications to address gaps in the evidence base. As part of this process, knowledge of contextual factors, (e.g., target group, setting) and research and evaluation methods, (e.g., survey development) was combined to develop practical solutions:

> *Everything we did, we tested and then (SiREN staff member) and I would have a discussion about it, and then... so, it went through several changes before we got an assessment tool (evaluation survey) ready to use… It meant I knew the assessment tool was going to be appropriate. The process was rigorous, we had thought of everything. (P12)*

The ability of SiREN to connect stakeholders from diverse backgrounds to address challenges is an indicator of effectiveness at the system level (77). Between 2012 and 2020, SiREN has led and supported over 14 collaborative research and evaluation projects that have bought together researchers, practitioners and policymakers from around Australia, including a large national competitive grant. This has generated $1.5 million in additional financial *resources for research and evaluation* within the system. SiREN acted as a relationship facilitator by connecting researchers across Australia with WA based organizations to support the development and implementation of applied research projects. The benefits of SiREN's connections were noted by one of its research partners:

> *The thing that's probably allowed us to consider WA more often, has been that not only having SiREN, but people who get that approach (applied research) and can kind of be the people that work directly with some of the agencies… what it means is it is a much more genuinely and true collaborative relationship… it's just really difficult to maintain a true collaborative project with that kind of distance. (P15)*

The development of *networks and partnerships* has a reinforcing relationship with engagement; increased connections within the system led to new stakeholders engaging with SiREN [**Figure 2**, reinforcing loop 2 (R2)]. *Networks and partnerships* also had a reinforcing relationship with creating and sharing evidence [**Figure 2**, reinforcing loop 3 (R3)]. A lack of contextually relevant research is acknowledged as a barrier to evidence-informed decision-making (81). To address this, SiREN has supported creating an evidence base relevant to WA's SHBBV unique priorities and challenges. This was achieved through two main strategies: building the capacity of stakeholders to generate research and evaluation evidence; and participating in, and facilitating collaborative partnerships between researchers, service providers and policymakers to create and share evidence. Knowledge sharing occurred at a system level and was facilitated by disseminating evidence, (e.g., learning resources, findings from research and evaluation projects) through its website, social media accounts, video case studies, regular electronic communications to its member network, (e.g., evidence summaries), and biennial 2-day research symposium. In addition, SiREN supported knowledge sharing by providing training, support, and resources to build confidence and skills of the SHBBV workforce to share research and evaluation findings at conferences and other fora. **Table 4** presents a summary of SiREN's tangible evidence and capacity building outputs which support the study findings.

TABLE 4 | Summary of SiREN's evidence and capacity building outputs from 2012 to 2020.

Activity	Output
Evidence building and translational research	
Peer reviewed journal articles	48
Reports / other publications	17
Conference abstracts, presentations, workshops, or posters	57
Workforce development and capacity building	
Hours of tailored research and evaluation support provided to 23 organizations	1,137
Events delivered or co-facilitated by SiREN	32
Post graduate students supervised (Honors, Masters and PhD)	33

The Application of Evidence to Decision-Making

Evidence created by SiREN and its stakeholders has been used by government to inform policy decisions at both the state and national levels. For example, SiREN recently completed an evidence review which informed the development of strategies that guide the response to SHBBV issues across the state of WA (82). In addition, organizations have used evidence created by SiREN to inform how their services are delivered. An example is the use of a report written by SiREN (83), which a participant described:

> *Staff refer to it (a report produced by SiREN) to inform the work they're doing around culturally and linguistically diverse communities... So that report certainly drove both local programs but also I think a lot of the advocacy work of WA to the rest of the country. (P14)*

Another way SiREN has supported evidence-informed decision-making is by assisting organizations to evaluate their programs. Evaluation findings were then combined with other sources of evidence, (e.g., research and experiential knowledge) to inform program delivery. This was explained by a manager whose non-government organization had received support to plan and evaluate each of their programs, including support to deliver focus groups:

> *We've increased the amount of evaluation that we've done to justify being able to do the things that we need to do to increase the services. We've got that (new service), and that's a genuine, direct result of the research that's been out there around the importance of taking services to people and also from us doing focus groups. (P9)*

DISCUSSION

A systems approach explored how and in what ways a research and evaluation capacity building project (SiREN) supported research, evaluation, and evidence-informed decision-making capacity within a system focusing on the prevention and management of STIs and BBVs (the system). Situating SiREN within the system enabled the research to address gaps in the existing capacity building literature. Including examining how contextual factors interacted with SiREN's ability to create change, how SiREN contributed to change across multiple levels, and the kinds of change it achieved (14).

Synergistic Engagement to Create Change

Synergistic (extended) engagement between SiREN, its service users and partners led to more impacts and outcomes than transactional (brief) engagement. While these different types of engagement are not depicted in the causal loop diagrams, describing them provides insight into the kinds of changes different capacity building strategies can achieve (7, 84). In the partnership literature, synergy occurs when partners combine their knowledge, skills and resources to develop effective solutions (77). Synergy is based on trusting relationships (85), which, once established, lead to more significant change. In this study, the effects seen from synergistic engagement are attributed to the presence of trust, adapting support to the service user's needs, and/or providing them opportunities to learn by doing. This aligns with theories of capacity building, highlighted in the introduction, that emphasize the importance of those involved being committed and seeing value in the capacity building process (7, 8). While this study and others (84, 86) acknowledge the benefits of transactional engagement strategies as part of a multi-component approach to building capacity, synergistic engagement had the ability to create sustainable change, (e.g., from increased individual research and evaluation skills to sustainable research and evaluation practice). These findings align with recent studies (7, 55, 84, 86), which found strategies that are needs-based and provide practical opportunities to apply learnings are an effective and meaningful way to build capacity.

Leverage Points

One of the most valuable insights gained through the use of causal loop diagrams was identifying key points of influence within the system. The development of trusting relationships between SiREN, its partners, and service users was identified as a point essential to SiREN's success. Trust had a reinforcing effect on engagement with SiREN [**Figure 1**, reinforcing loop 2 (R2)]. While trust is widely accepted as a fundamental component of effective partnerships (36, 77) and research capacity building efforts (7, 87, 88), it has not been explored within the evaluation capacity building literature (89). This research suggests that development of trust in evaluation capacity building parallels the research capacity building and broader partnership literature. The findings indicate trust was predicated on credibility, reliability, and power-sharing to define problems and shape solutions (85, 90). The role these factors played was evident in the trust-building effects of meeting expectations, boundary-spanning skills of the SiREN team, and the collaborative processes of aligning SiREN to stakeholder needs. Identifying leverage points enables action on these points of influence to strengthen its functioning (91).

Change Across the Individual, Organizational, and System Level

There is a need for capacity building programs to focus on change at a system level (e.g., creation of shared research priorities, priorities of funders, partnerships, and sustainability) (92). An evaluation of SiREN, undertaken 2 years after initial funding, identified individual-level improvements to research and evaluation attitudes, knowledge, skills and confidence (25). For the present study, data were collected up to 8 years after SiREN was established and showed these individual-level changes had continued and identified further changes evident across individual, organizational and system levels. Organizational level changes were co-created research and evaluation solutions, mainstreaming evaluation, and evidence-informed decision making. System level changes included increased resources for research and evaluation (e.g., funding), the development of networks and partnerships that led to more efficient responses to emerging issues (e.g., collaborative research priority setting), evidence sharing, and sustainable research and evaluation practice. While many system level changes begin at the individual level (e.g., support to undertake a research project), they can reverberate across the system over time when they occur through synergistic engagement. This "ripple effect" theory has been identified previously in the research partnership literature (88). The sustained investment in SiREN by its primary funder provided the resources to achieve these valuable longer-term changes. Supported by this research is the need for greater awareness that capacity building initiatives may not yield outcomes in the first few years. This finding is important to manage stakeholder expectations of what can be achieved and identify appropriate evaluation time points. This is a valuable consideration for groups interested in implementing capacity building initiatives, particularly in negotiating key performance indicators with funding organizations or the timing of evaluation.

The authors acknowledge that SiREN is just one of many influences on research and evaluation practices within the system. While SiREN elicited meaningful change at an individual and organizational level, which has rippled outwards to system level change, its ability to produce change directly at the system level is limited by its scope and size. Adding to this challenge is that complex systems exist in a permanent state of change (93). In this system, there is a perpetual movement of staff in and out, there are changes to funding, and epidemiological variations occur requiring new resources and evidence to respond. There is need for continuous capacity building in public health (94), yet how to achieve sustained change from capacity building strategies requires further exploration (84). SiREN's continued investment in aligning its services and resources to the needs of stakeholders support its ability to address emerging changes. Furthermore, its contribution to embedding evaluation as part of regular practice in the system and the continuous learning opportunities it provides increase sustainability by ensuring that the impacts of its capacity building strategies efforts do not diminish over time (2). Therefore, system level capacity building projects need to be flexible and responsive to change within the system they operate and approach capacity building as a continual process rather than an end point.

Many of the impacts and outcomes achieved align with what is widely known in the capacity building literature, e.g., changes to knowledge and skills, the establishment of networks and partnerships (2, 86, 87). However, unexpected changes were also identified, including increased clarity amongst SiREN service users of their program purpose, processes and credibility of programs. Identifying unanticipated outcomes demonstrates the benefit that a systems approach contributed to understanding SiREN's changes. Systems approaches go beyond measuring the extent to which pre-determined objectives or goals are met, which is a common end-point in more traditional evaluation approaches. The detection of unexpected outcomes suggests the evaluation of capacity building projects can be strengthened through approaches that are sensitive to their complexities (43).

Development of Practical Indicators

One of the aims of creating the causal loop diagrams was to gain an in-depth understanding of SiREN to inform the subsequent development of a comprehensive evaluation framework. Causal loop diagrams can support the identification of high quality and useful indicators (21). Insights from this study have since been used to develop specific indicators to monitor SiREN's processes, impacts and outcomes. For example, the presence of trusting relationships has been identified as an important indicator due to its reinforcing effect on engagement. In addition to an evaluation framework, a questionnaire for SiREN service users was subsequently developed based on findings (described in a forthcoming publication).

Strengths and Limitations

The use of causal loop diagrams and supporting quotes provided credible explanatory links between SiREN and changes that occurred (95). In addition, the causal loop diagram illustrating factors that influence engagement with SiREN strengthens understanding of how contextual variables interact and affect implementation and effectiveness. Explaining contextual factors and their relationship to the functioning of SiREN avoided over or under-stating causality and ensured key elements that influence functioning were not obscured.

In public health, many causal loop diagram studies are created only by the researcher team, without input from stakeholders (96). Collaborative model building processes can help stakeholders overcome difficulties with interpretation (97), develop a shared understanding of how systems variables and relationships drive change (21) and create consensus on how to address the issue illustrated by the diagram (97). The process and value of the collaborative model building was not assessed in this study. Most protocols for developing casual loop diagrams focus on the early stages of group model development (98, 99). Guidance on validating diagrams at later stages of development is limited to individual interviews (33, 100). Refining diagrams using individual interviews may be better at clarifying and capturing different perspectives when compared to group methods (101). Future causal loop diagram studies could examine group processes of model development at the later stages of model development.

As staff employed by SiREN's primary funder declined to participate, the study findings do not include their perspectives. This may mean that some impacts and outcomes were not identified. As with any modeling, simplification was required. Not all feedback loops were reported for the diagram depicting impacts and outcomes as they were too numerous and would overcomplicate the presentation of study results. Instead, the diagrams are supported through additional detail provided by the narrative description.

As members of the research team are involved with SiREN, social desirability bias may have occurred during data collection (102). This was reduced by utilizing a variety of data collection methods, providing participants with assurances of confidentiality, probing to clarify in-depth interview responses, and discussing data collection processes with the SiREN team (102). Several strategies addressed the limitations associated with insider research and a single researcher collecting data and conducting primary analysis. Trustworthiness was increased through data triangulation, reflective journaling and regular meetings with the research team during data collection and analysis to discuss and refine emerging findings (103). During these meetings, a team member who was not involved in SiREN was present to enhance objectivity (103). In addition, diagram elements were linked to data sources in a reference table (70), and the diagram was validated with participants, a form of member checking (104, 105). The diagram was modified for publication after this validation process. The changes were based on data collected and included splitting the diagram into two and adding additional variables and relationships. These changes

were intended to increase the accuracy of the diagram and support its interpretation in published form. Refining diagrams after data collection has ceased has been used in previous studies and aligns with good model building practice (106). Furthermore, developing "reader friendly" casual loop diagrams requires considering how the diagram functions as an effective tool for communicating findings (96). However, changes were not checked with original participants, which may have reduced the trustworthiness of the diagrams. Data collection occurred up to 2 years after some participants engaged with SiREN resulting in potential recall bias. However, this longer-term follow-up enabled the identification of outcomes that would not have been distinguishable immediately after engagement had occurred.

CONCLUSION

This study used causal loop diagrams to provide new insight into how a partnership-based project contributed to building research and evaluation capacity. Findings suggest a complex interplay of contextual and process factors promoted engagement with SiREN, which resulted in research, evaluation, and evidence-informed decision-making capacity improvements within the system. The use of causal loop diagrams highlighted key leverage points that may be exploited to facilitate improvement and evaluation. The focus on contextual factors and their relationship to engagement provide valuable guidance for researchers, policymakers or practitioners seeking to develop or evaluate a similar capacity building partnership.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Curtin University Human Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

The study was conceptualized by RT, JH, BM, and RL. RT undertook recruitment, data collection and analysis with input and supervision from RL, JH, and BM. RT drafted and edited the manuscript. RL, JH, BM, and GC provided critical feedback. All authors have approved the final manuscript.

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Pivoting from systems "thinking" to systems "doing" in health systems—Documenting stakeholder perspectives from Southeast Asia

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Applications of systems thinking in the context of Health Policy and Systems Research have been scarce, particularly in Low- and Middle-Income Countries (LMICs). Given the urgent need for addressing implementation challenges, the WHO Alliance for Health Policy and Systems Research, in collaboration with partners across five global regions, recently initiated a global community of practice for applied systems thinking in policy and practice contexts within LMICs. Individual one on one calls were conducted with 56 researchers, practitioners & decision-makers across 9 countries in Southeast Asia to elucidate key barriers and opportunities for applying systems thinking in individual country settings. Consultations presented the potential for collaboration and co-production of knowledge across diverse stakeholders to strengthen opportunities by applying systems thinking tools in practice. While regional nuances warrant further exploration, there is a clear indication that policy documentation relevant to health systems will be instrumental in advancing a shared vision and interest in strengthening capacities for applied systems thinking in health systems across Southeast Asia.

KEYWORDS

systems thinking, Southeast Asia, health systems, low and middle income countries (LMICs), health policy and systems research (HPSR)

Introduction

For more than a decade, there has existed a broad consensus on Systems thinking (ST) offering strong potential, both as a lens and as a set of methods for strengthening health systems (1–3). In the wake of ever-widening health inequities exacerbated by an ongoing pandemic (4), conflict (5), and anthropogenic climate change (6), the case for moving away from reductionist approaches and viewing health systems as complex, adaptive systems is strong.

In recent years, a growing chorus calling for a shift in systems thinking from the current 'research-to practice' model toward an applied research paradigm has gained momentum (2, 7–9). The implementation of ST tools for overcoming complex healthcare system challenges across knowledge mobilization, workforce planning (10, 11), and

neglected tropical diseases (12, 13), among others, has been promising. However, relative to the widespread endorsement of ST methodologies in disciplines dealing with complex systems [such as engineering, biology, and management (14, 15)], applications in the context of Health Policy and Systems Research (HPSR) have remained scarce, particularly in low- and middle-income countries (LMICs).

There are reasons for this. Firstly, despite the growing body of literature, resources available for supporting systems thinking implementation in the context of HPSR tend to emphasize conceptual writing with an almost exclusive focus on theoretical, as opposed to practical applications (16, 17). Moreover, policymakers often tend to receive abstract problem descriptions from systems scholars rather than tangible assistance and input on what ought to be done (18, 19).

Secondly, capacity-building initiatives for applied systems thinking are generally not calibrated well for adapting to existing relationships between internal (individual and organizational) and external (policy and socio-political environment) stakeholder groups across health systems (20). Long-term implementation of ST within various HPSR contexts requires stakeholders to have more than just knowledge of how ST tools can be applied–an understanding of who wields power over decision-making processes is an important consideration too (21).

Lastly, and perhaps most importantly, little is known about how policymakers actually engage with ST, or how the dynamics of collaboration between multisectoral stakeholder groups facilitate (or hinder) this engagement. Moreover, a lack of documented examples of applied systems thinking within HPSR contexts in LMIC settings further skews policymaker perceptions of ST being largely conceptual and irrelevant for policy implementation (22, 23).

Given the need for addressing these lacunae, the WHO Alliance for Health Policy and Systems Research (WHO AHPSR), in collaboration with partners across five global regions launched a Systems Thinking Accelerator (SYSTAC) in 2021 (24). Drawing from an outgrowth of learnings from the Systems Thinking for District Health Systems project implementation in Timor Leste, Pakistan, and Botswana, (25) SYSTAC was operationalized as a global community of practice for applied systems thinking in policy and practice contexts within LMICs.

Over the past year, for defining the initial engagement strategy and developing the project scope for SYSTAC, partner institutes conducted a series of regional consultations. The aim of these consultations was to: (1) Understand the needs of practitioners, researchers, and decision-makers for improving capacities in applied systems thinking across regions, (2) Elucidate key barriers and opportunities for applying systems thinking in specific settings, and (3) Catalog potential actors and initiatives in the region to explore collaborative cross-regional partnerships.

We present here, perspectives gathered through one-on-one virtual consultations with 56 researchers, practitioners, and decision-makers across nine Southeast Asian countries as part of a regional needs assessment, conducted between April 2021 and June 2021 (NB. outreach is still ongoing) (Figure 1). Participants were identified through existing networks, web searches of publications and institutions related to systems thinking, and recommendations of other participants and global SYSTAC network members. Virtual conversations on Zoom were held with participants ranging in duration from 30 min to over an hour and covered understandings of systems thinking, key needs, existing challenges, and future directions for driving a greater implementation of systems thinking across HPSR contexts across the region.

The need to explore the lexicon of systems thinking in the context of Southeast Asia

Practitioners and researchers from Thailand noted that although there was an overlap between the conceptual understanding of systems thinking, approaches toward it varied across regions. In some cases, there was familiarity with and use of systems thinking, while in others there were approaches using local idioms and terminologies that could be seen to be similar to systems thinking, for example like "*Bhinneka Tunggal Ika*" (loosely translated to mean unity in diversity) in Indonesia. This was further corroborated by researchers and decision-makers in Sri Lanka, and Bhutan along with broader literature (26, 27).

While certain health reforms across the region [such as Bangladesh's constitutional commitments for social justice (28) or Bhutan's Gross National Happiness Index (29)] incorporated many of the underlying tenants of systems thinking approaches, they were not intentionally guided by the approach. Instead, these adopted an ethos of commitment to inclusion and broad-based reform, drawing upon tacit knowledge (i.e., not derived from formal research) and cultural nuances (like "*Bhinneka Tunggal Ika*" in Indonesia), which, by their nature, involved variations of classic systems thinking methodologies such as network analysis, outcome mapping, etc.

A decision-maker in Timor Leste expressed that while there was an openness to the concept of applied ST in his country, the very term "systems thinking" felt esoteric and made it daunting for broader health systems actors. A small minority of individuals also took the view that the nomenclature of systems thinking, and interrelated concepts–were all in English and predominantly adopted a western approach to implementation

Country	Stakeholder Type		
	Researchers	Practitioners	Decision Makers
Bangladesh	8	2	-
Bhutan	1	-	5
India	8	4	-
Indonesia	1	1	-
Myanmar	1	3	-
Nepal	1	3	-
Sri-Lanka	4	3	1
Thailand	3	1	1
Timor Leste	2	2	2

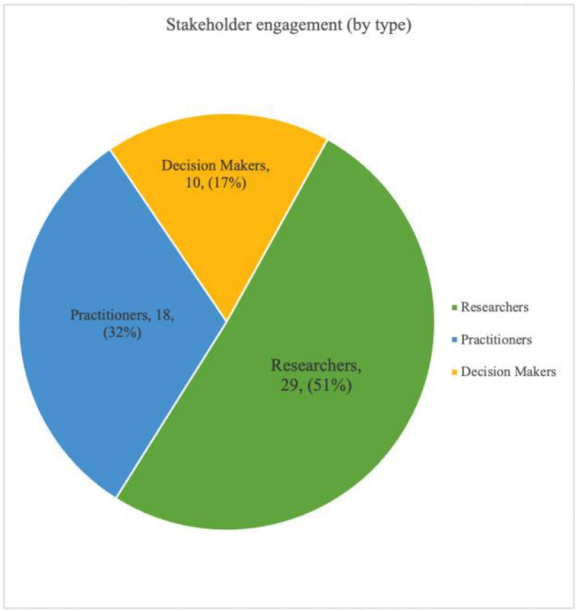

FIGURE 1
Stakeholder engagement and outreach statistics.

which could have (in part) served as an impediment to wide-scale adoption across Southeast Asia.

In the consultations, it became clear that there was a need to explore alternative regional framing similar to applied systems thinking as well as a more explicit theorization of its application in HPSR. A former deputy minister of public health in Thailand, with prior experience using ST tools, suggested introducing the concepts through the lens of "learning health systems" (30), to "explore synergies with other ongoing health systems strengthening projects across the region."

The need to strengthen capacities for sustained application of systems thinking in HPSR

Multiple stakeholder groups including practitioners, decision-makers, and researchers across Sri Lanka, Bhutan, Nepal, and Bangladesh expressed interest in engaging with participatory skill-building workshops demonstrating the "how" of applied systems thinking. Access to information and resources including (but not restricted to) webinars, publications, online courses, and research coalitions were identified as means to better understand the scope of applied systems thinking. Support for programming and research in the region was also called for, such that such training would not remain a disembodied, siloed exercise from ongoing regional work.

To advance this, practitioners and researchers from India suggested a potential integration of systems thinking modules into existing HPSR capacity strengthening initiatives such as the Health Innovation Fellowship (31) and the Health Policy and Systems Research fellowship (32).

For the sustainable implementation and capacity-strengthening across various contexts, however, the importance of designing a Theory of Change (ToC) (33) was underscored by multiple stakeholder groups across the region. During these discussions, an explicit emphasis was placed on considerations for delineating the scope ("how far we go"), shared understanding ("what terms we use"), and bespoke implementation strategies ("how we move things").

The need to demonstrate tangible, policy-relevant benefits of systems thinking approaches to implementers

Consultations with practitioners and researchers from Timor Leste, Myanmar, and Nepal (where adoption of systems thinking continues to be at a relatively nascent stage), reaffirmed that programming within ministries of health tended to default to vertical approaches for problem-solving across health systems. Such approaches, (with a narrow focus and scope) were associated with greater efficiency and higher success ratios. In these contexts, driving the adoption and implementation

of systems thinking tools at a policy level continues to pose a challenge. In the absence of a priori high commitment and interest on the part of decision-makers, there was an almost unanimous regional consensus on the need to demonstrate merit in the applicability of ST methodologies in improving community health outcomes relevant to local policy contexts.

Discussion

While a lot of the discussions during the consultations served as reaffirmations to longstanding implementation challenges of ST tools in HPSR, the findings showcase the potential for collaboration and co-production of knowledge across diverse stakeholder groups for strengthening opportunities for applying systems thinking tools in practice. Going forward, it could be interesting to study the role of collaboration in enhancing the policy-relevance of research outputs. In the context of applying ST in HPSR, understanding the value and uptake of research by policy partners, and strengthening capacities for research *via* intellectual capital (knowledge) and social capital (relationships) could be an important dimension.

The discussions also shed light on the fact that in many countries across Southeast Asia, ST may have been applied across health strengthening programs under the guise of tacit knowledge and deep-rooted cultural practices. This provides an opportunity to take note of how systems thinking is approached and practiced in different countries, which can help policymakers identify processes that could be replicated. Careful documentation of the contexts undergirding these applications and their impacts on population health outcomes is a crucial next task that must not be overlooked.

One approach for documenting these exemplars could be as part of case book compilations geared toward policymakers. Case compilations in this context could prove useful as the methodology is often recommended for presenting data in a relatively accessible manner (34, 35). Due to their focus on localized contexts, these could further assist policymakers in relating to and drawing conclusions from their own experiences. Another component for the widespread accessibility of systems thinking tools and methodologies in the context of HPSR requires a deliberate consideration of challenges posed by the unique linguistic diversity of >2,000 languages (36) across Southeast Asia. The local translation of content and resource material(s) on systems thinking could prove to be another key supplemental avenue for exploration.

Similar to the ones presented here, insights from stakeholder perspectives gathered across the global regions are being implemented across multiple, ongoing SYSTAC activities. While much remains to be explored, an overarching sentiment of fostering a shared vision and interest in strengthening capacities for applied systems thinking in HPSR across Southeast Asia is evident. Building upon this vision calls for an adherence to the heart of any systems approach–forming networks, maintaining dialogue, and actively pivoting applied systems thinking in health systems from a theory-driven (systems thinking) to an applied research (systems doing) paradigm.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

DN framed, supervised the work, reviewed, and provided feedback. SS wrote the first draft and submitted the manuscript. Both authors contributed to the article and approved the submitted version.

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Redefining the health system: A proposed updated framework of a systems approach to health

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Defining the health system, as a multidimensional and complex structure, is challenging, and the existing definitions often fail to incorporate the various levels and functions involved in a single system definition. An ideal framework should be easy to evaluate, allow for comparison, and be divisible into smaller sub-systems for easier interpretation. This paper concisely explores a novel framework to perceive health systems. As in any system, it is important to accurately define the health system's input, process, and output, as the cornerstone of evaluating any system is to assess outputs with regard to inputs besides analyzing outcomes, impact, objectives, and values. Since the raison d'être of the health system is to improve health in society, it is proposed that the input can be considered as the population subject to the system's process, and the output as the population with improved health status. This paper also proposes defining support systems, whose input and output are needs and parts of the process in the main system, respectively. Example support systems include the health evidence production or education and development of human resources systems. Instead of considering all functions as part of the main system, this concept allows implementation and assessment of policies in various levels of health systems to be simplified, as each support system can be separately evaluated with clear functions.

KEYWORDS

health system, systems thinking, health system actors, support system, health system - organization and administration

Introduction

Health systems around the world play a vital role in shaping the health outcomes of individuals and societies (1). Their impact even extends beyond this point, as health is established as an important determinant of sustainable economic growth, security, equity, and effective governance (2, 3). Health systems are complex and multi-dimensional structures operating as dynamic social systems, for which various definitions have been proposed (1, 4–8). However, the existing definitions of health systems are nebulous and often reductionist (2). Furthermore, current definitions are disparate and do not enable comparison between countries (9, 10).

Perhaps the most extensive description of a health system so far has been provided by the WHO. According to WHO a health system includes "*all the activities whose primary purpose is to promote, restore, and maintain health,*" which encompasses all organizational and individual efforts that impact health, beyond "*the pyramid of publicly owned facilities that deliver personal health services*" (1). This definition tries to capture the wide-ranging structure and function of the health system—an aspect that other existing definitions fail to consider. Nevertheless, our focus has mainly been on what constitutes the health system, its functions, desired outcomes, and its values (11, 12); therefore, our challenge is to clarify the definitions of multiple levels and domains involved in health systems. In this regard, a comprehensive and integrated framework can help better understand, evaluate, and resolve the current issues in health systems.

In this communication, we present a new framework for defining the health system from a broader perspective.

The proposed framework

The standard systems approach incorporates an "input" that undergoes a "process" to achieve a specific "output," which then enables the system to meet its "outcomes" of interest and exert a desired "impact."

According to the definition of WHO presented above, the mission of health systems is to improve health in the target population (1, 13). In its simplified form, therefore, the population is the system's input, and the process involves activities aimed to deliver a population with improved health as output (Figure 1).

Input

Quantification and assessment of inputs is a crucial aspect of a system's evaluation, but defining inputs is elusive. In existing definitions, human resources, healthcare infrastructure, or even funding are often considered inputs (4, 13, 14). But the true input, which is the target of the process and is meant to be modified by the system, is the population and its level of health. The population is often considered as an external beneficiary and a recipient of services (2); however, a systems approach to health should prioritize the population. In this suggested framework, the population takes center stage, as we emphasize that the institutions and individuals who provide health services are not the whole systems, but they are part of the process of performing important functions of the system. The population itself can then be stratified based on health status for better characterization of the input, and each stratum can be perceived as a sub-input.

Abbreviations: WHO, World Health Organization; HEPS, health evidence production system; HRS, health research system; HIS, health information system.

Process

The collection of efforts, strategies, and structures that are implemented in coordination to improve the health status of the population can be regarded as a process, which includes different functions of the health system, and each function itself can be interpreted and examined in core domains of policy making and planning, resource generation, service provision, monitoring, and regulation (Figure 2).

System actors

Actors in the system are part of the process and are defined as any individual or organization that provides or receives health services. Government is a prominent actor involved in policymaking and planning, monitoring, and regulating the system. In certain circumstances, the government can be involved in resource generation and service provision to enhance outcomes; however, it is often not clear when and how this should be done, and how to evaluate the cost-effectiveness of this strategy. With the existing ambiguity in health system definition and the inability to compare system parameters between countries, the degree of government involvement in the health system is mostly determined by subjective preferences or national ideologies. Notably, we emphasize all branches of the government and not only the health department or ministry, as the state contributes as an actor through all policies that concern health.

The private sector, insurance companies, charities, and people themselves are other actors in the system. The private sector is distinctively active where there is profit, and it is up to governments to regulate the market to produce incentives for private sector participation. Insurance acts as an important factor to determine health-related costs and facilitates receiving timely interventions. Insurance companies can either belong to the private sector or be government-controlled. Charities are unique in that they do not seek financial gain, yet they can intervene wherever they deem necessary to increase the system's efficiency. People play a role in the system through self-care, good health knowledge, and most importantly the role of receiving care.

Figure 2 demonstrates a simplified approach to how actors engage in different functions of the system process in each core domain. In this framework, each cell in Figure 2 can represent a subsystem that is assigned to the specific actor(s) responsible for that domain, and then the efficiency of each cell can be evaluated with appropriate indicators.

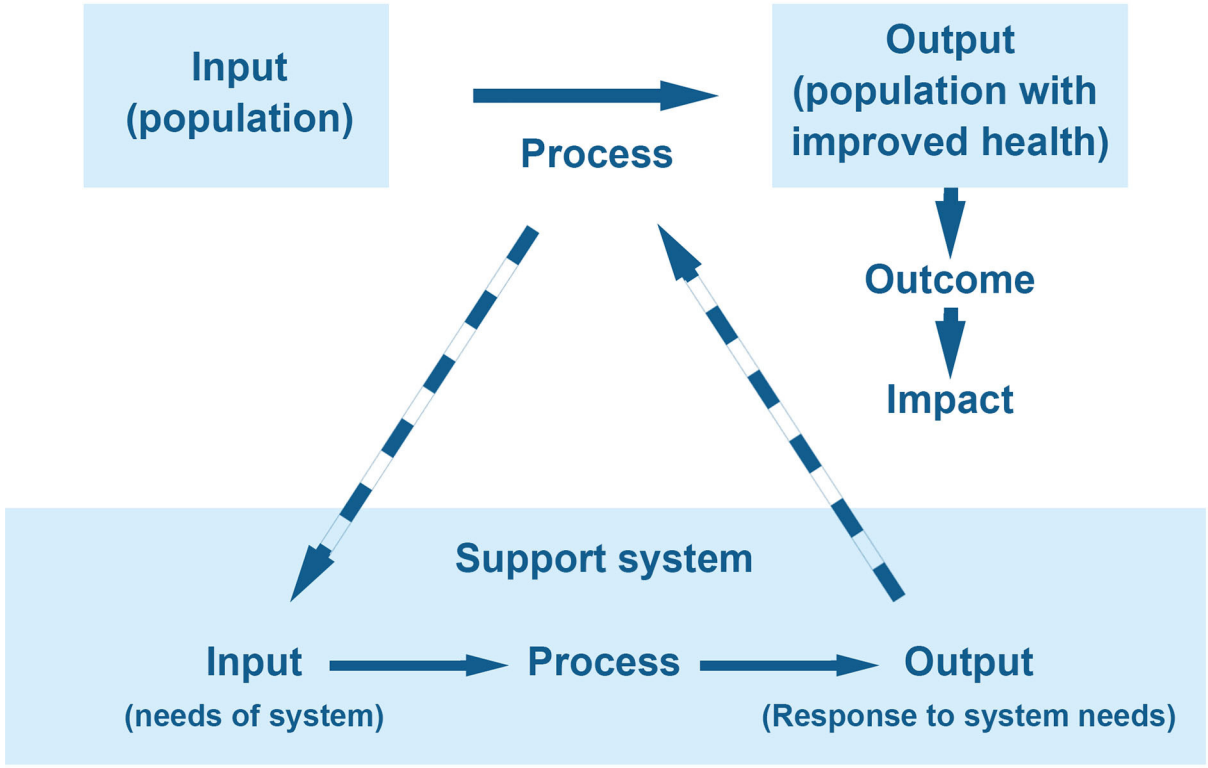

FIGURE 1
Overview of health system structure.

	Policy-making & planning	Payment & cost supply	Service provision	Monitoring & market regulation
Prevention of disease risk factors (Primordial prevention)	Government	Government Charities People	Government Charities	Government
Prevention of disease incidence (Primary prevention)	Government	Government Insurance companies Charities People	Government Insurance companies Charities	Government
Detection and prevention of disease prevalence (Secondary prevention)	Government	Government Insurance companies Charities People	Government Insurance companies Private sector Charities	Government
Detection and prevention of disease complications (Tertiary prevention)	Government	Government Insurance companies Charities People	Government Insurance companies Private sector Charities	Government

FIGURE 2
A simplified framework showing how system actors are tasked with different functions of the system process (rows) in each core domain (columns). Each cell represents a subsystem that is assigned to the specific actor(s) responsible.

Output

Quantification and evaluation of the system's output are even more challenging than defining the input (14, 15). Since the raison d'être of the health system is better health in the society (1), the output can be described as the population with improved health outcomes. Indeed, the output can also be stratified into different levels of health status like the input and should be assessed with appropriate output indicators in terms of its attributes. For instance, the output can be the reduction in the number of incident diseases or the number of people who receive education or get vaccinated.

Outcome and impact

Health outcomes have been extensively examined with a systems approach (7, 15). Outcomes refer to the objectives of activities performed in the health system process, e.g., an outcome of hypertension screening is to reduce the incident cardiovascular events associated with high blood pressure. Ultimately, the desired outcome of the system is the reduction of morbidity and mortality. On the other hand, system impact is concerned with the health status of the target population. The most important impact is of course improved life expectancy and health expectancy, which refers to disability-free and active life in good perceived health (16).

System environment

Health system is not isolated and is affected by its territorial ecosystem and other social structures. The bilateral relationships of the health system with other social systems such as education, economy, and sources of power determine almost all aspects of health in the society.

Support systems

Several systems that are commonly regarded as components of a health system can be better defined as support systems. This new definition is helpful in characterizing each component and avoids common problems in analyzing the system and assigning objectives. A support system is defined according to three properties:

A) Its existence takes meaning with the main system. If the main system did not exist, there would be no reason for the support system.
B) Its input is a need of the main system.
C) Its output is used in the process of the main system (Figure 1).

Crucially, this framework serves to simplify the evaluation of these support systems, not undermine their value as accessories. For clarification, two important support systems are discussed herein.

Health evidence production system (HEPS) consists of a health research system (HRS) and a health information system (HIS). *HEPS* input is the collection of questions and hypotheses created in Figure 2 cells, and its output is the evidence that will then be used in the health system process.

Education, development, and support of human resources should be regarded as a support system and not part of the health system itself. In this regard, the main system's need for trained professionals is the input, and the outputs are professional health care providers who are part of the process in the health system. Notably, this support system should also be assigned the goal of improving the work life of health care workers (17). Notwithstanding this need, the objectives of this support system are sometimes overlooked, and its output is not tailored to the requirements of the health system.

System values

Values should not be mistaken with objectives, aims, goals, or outcomes. A system cannot function without its values, and its output is not meaningful without meeting system values first. Safety, equity, accountability, international collaboration, quality, and safety are better defined as values of the system. Values act as the inner compass of the system and are there to assure it remains on the right path. Every system has its own set of values, which are decisive in defining goals and directions. While values are instrumental to the success of the system and should be evaluated and monitored, they are distinct from goals.

Conclusion

In this communication, we propose a new concept of a health system based on the classic attributes of a system. First, we attempt to simplify the description of inputs and outputs of the health system. Establishing the correct definition of inputs and outputs—a feature that has often been neglected—is crucial in health systems, since analyzing and comparing outputs with regards to inputs, or vice versa is the core of efficiency measurement in any system (14, 18). As mentioned, the input and output can be stratified based on health status but can be further characterized by demographics, insurance coverage, perceptions of health, health literacy, and so forth. The properties of the input are among the factors that determine the activities in the process and should be considered when comparing health systems between countries.

Second, we propose using the concept of support systems to separately evaluate various levels and functions of the health system. This approach breaks down parts of the system, which are hard to fit under a single definition, into smaller support systems that are assigned different functions and are easier to evaluate.

Third, we suggest a differentiation between system values, aims, and outcomes. Importantly, each element should be assessed with its specific indicators to avoid confusion in the system.

Based on these concepts, future efforts are needed to improve this health system framework. The next steps may focus on the analysis of sub-systems and support systems and attempt to determine the role of each actor in the system with respect to its capabilities.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Author contributions

FA and HE contributed to conception and design. FA and HT wrote the draft manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Cross-sector decision landscape in response to COVID-19: A qualitative network mapping analysis of North Carolina decision-makers

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Introduction: The COVID-19 pandemic response has demonstrated the interconnectedness of individuals, organizations, and other entities jointly contributing to the production of community health. This response has involved stakeholders from numerous sectors who have been faced with new decisions, objectives, and constraints. We examined the cross-sector organizational decision landscape that formed in response to the COVID-19 pandemic in North Carolina.

Methods: We conducted virtual semi-structured interviews with 44 organizational decision-makers representing nine sectors in North Carolina between October 2020 and January 2021 to understand the decision-making landscape within the first year of the COVID-19 pandemic. In line with a complexity/systems thinking lens, we defined the decision landscape as including decision-maker roles, key decisions, and interrelationships involved in producing community health. We used network mapping and conventional content analysis to analyze transcribed interviews, identifying relationships between stakeholders and synthesizing key themes.

Results: Decision-maker roles were characterized by underlying tensions between balancing organizational mission with employee/community health and navigating organizational vs. individual responsibility for reducing transmission. Decision-makers' roles informed their perspectives and goals, which influenced decision outcomes. Key decisions fell into several broad categories, including how to translate public health guidance into practice; when to institute, and subsequently loosen, public health restrictions; and how to address downstream social and economic impacts of public health restrictions. Lastly, given limited and changing information, as well as limited resources and expertise, the COVID-19 response required cross-sector collaboration, which was commonly coordinated by local health

departments who had the most connections of all organization types in the resulting network map.

Conclusions: By documenting the local, cross-sector decision landscape that formed in response to COVID-19, we illuminate the impacts different organizations may have on information/misinformation, prevention behaviors, and, ultimately, health. Public health researchers and practitioners must understand, and work within, this complex decision landscape when responding to COVID-19 and future community health challenges.

KEYWORDS

COVID-19, community health, cross-sector collaboration, decision-making, crisis response

Introduction

Declared a pandemic by the World Health Organization on March 11, 2020 (1, 2), the coronavirus disease 2019 (COVID-19) continues to rapidly spread, resulting in over 6 million deaths worldwide as of March 2022 (3). COVID-19 has posed the most challenging and complex global health crisis in at least 100 years. Specifically, the complexity of COVID-19 has been characterized by: uncertain and rapidly changing information; interdependencies and feedback loops between decisions made by many individuals/organizations with different perspectives and their outcomes across organizational and sector boundaries; and time lags between policy changes and their ripple effects (4, 5).

In the United States, though federal guidance has been issued, the COVID-19 pandemic response has largely been implemented at the state and local level, involving ongoing decision-making by stakeholders across numerous sectors at these levels. Even before COVID-19, with the increasing recognition of the social and economic influences on health and health inequities, promoting local community health has demanded the involvement of numerous sectors operating at multiple levels of influence (e.g., individuals, organizations, policy-making).[6] Health outcomes are thus collectively produced by a broad spectrum of stakeholders—defined as individuals and organizations with an interest in a given problem and its resolution (7, 8)—acting in accordance with their own goals, incentives, knowledge, and mental models of the problem at hand (9).

As a result, local community health promotion can be conceptualized as a complex system in and of itself, with interactions between different sectors resulting in feedback loops producing emergent properties across the entire system (6). In complex systems theory, emergent properties develop when systems evolve over time and develop effects that are different, or greater than, the sum of their parts (10, 11). In the context of community health, such properties could be understood as different dimensions of the community's health and safety (e.g., access to healthcare, safe environmental conditions, a positive culture of healthy behavior, etc.,). For this reason, studying the independent parts of a system, including decision-making within different sectors, is not sufficient to understand the emergent system properties influencing system outcomes. It is the collective decision-making of all stakeholders within the community that produces the overall level of community health.

Given the complexity of the COVID-19 pandemic, layered on top of the already complex landscape of local community health promotion, studying the local pandemic response demands a complex systems approach that recognizes the distinct yet interconnected stakeholder roles shaping decisions within and across organizational boundaries (12). In the context of a local pandemic response, stakeholders range from individuals deciding whether to wear a mask to local public health officials developing and communicating guidance around mask usage (13, 14). Given the influence that organizational policies had on individual-decision making during the pandemic, we bounded our study of the local pandemic response by focusing on organizational decision-makers, defined as individuals whose job responsibilities included making decisions with a substantial impact on the organization as a whole or individuals the organization serves.

Specifically, we sought to study the local cross-sector decision landscape emerging in response to the early-stages (first year) of the COVID-19 pandemic in North Carolina, a large, diverse state in the US with several metropolitan centers. North Carolina's local public health system is comprised of 85 local health departments, most commonly organized at the county-level (there are 100 counties in North Carolina). Historically, public health agencies have collaborated with county emergency management divisions for emergency preparedness and response—especially in response to hurricanes in the eastern region of the state—with several counties merging the role of public health preparedness coordinator with emergency management (15, 16).

We define the local cross-sector decision landscape in terms of *who* is involved in making decisions that affect community health, the *relationship* between decision-makers' roles and the types of decisions made, and the methods of *influence* between different stakeholders within the same community. Viewed through a complex systems lens, we considered decision-makers' organizations as *nodes* and the connections between them, formed through the decision-making process, as *interrelationships*. We conducted a network mapping-based qualitative analysis of organizational decision-makers in North Carolina.

Improving health, particularly amidst crises such as COVID-19, requires coordinating complex decision landscapes. This analysis illustrates a replicable approach to mapping and characterizing a complex organizational decision landscape. Within the context of the various organizational perspectives, priorities, and incentives involved in community health, the results of this analysis serve to inform decision-making by public health practitioners and researchers when responding to this and future infectious disease outbreaks, as well as other complex public health challenges that require system-level coordination.

Materials and methods

Sample description and recruitment

Defining sectors as subdivisions of society that include similar types of agencies or organizations serving distinct functions (7, 17), we interviewed state and local decision-makers from nine sectors: **business** (n = 4; small business owners, real estate agent, technology company director; B1-B4), **non-profit organizations** (n = 3; senior director, vice presidents (VP) of operations and risk management; NP1-NP3), **county government** (n = 4; county managers, director of social services; G1-G4), **healthcare** (n = 5; directors/VPs of healthcare associations, systems engineer, director of student health; H1-H5), **local public health** (n = 5; local health directors; PH1-PH5), **public safety** (n = 7; emergency managers, county sheriffs; PS1-PS7), **religion** (n = 6; church pastors, member of church COVID taskforce; R1-R6), **education** (n = 7; principal, school board member, community college president, university vice president; E1-E7), **transportation** (n = 3; transportation planner and pedestrian coordinator, traffic safety engineer; T1-T3) (Table 1).

Given the challenge of asking organizational leaders to meet during the early stages of the pandemic, we used a snowball sampling approach, starting with intentionally diverse decision-makers recommended by our research team and their cross-sector contacts. We then asked interviewees for referrals to decision-makers in related organizations who may provide a meaningful and diverse perspective from their own. We interviewed 44 of the 120 potential interviewees contacted (37% response); four interviewees were previously known to one or more coauthors. Of those contacted who did not complete an interview, most did not respond to our email request. As such, we are not able to know the exact reasons for non-response. However, we suspect that this was due to the substantial competing demands of organizational leaders during the first year of the pandemic. No candidates explicitly refused to participate due to hesitation surrounding the study objectives. We determined sample size by reaching thematic saturation across sectors and ensuring at least three interviews within each sector. While the interviewees do not represent an exhaustive list of organizations responding to the pandemic, the objective of our sampling approach was to recruit decision-makers from diverse organizations and ensure representation across sectors and the state of North Carolina.

TABLE 1 Characteristics of organizations represented in interviews with local decision-makers (N = 44).

Organization characteristics	*N* (%)
Sector*	
Public safety	7 (16%)
Education	7 (16%)
Religious organization	6 (14%)
Local public health	5 (11%)
Healthcare	5 (11%)
County government	4 (9%)
Business	4 (9%)
Non-profit organization	3 (7%)
Transportation	3 (7%)
Region of North Carolina	
Eastern (Coastal Plains & Sandhills)	9 (20%)
Piedmont	23 (52%)
Western (Mountains & Foothills)	5 (11%)
Multiple regions	7 (16%)
Rurality of county†	
Metropolitan	32 (73%)
Non-metropolitan	4 (9%)
Multiple counties	8 (18%)

*Interviewees within each sector represented different types of organizations, Public Safety (County Emergency Services/Management, County Sherriff's Office); Education (Universities, Community college, Private & public grade schools, School board); Religious Organization (Church leadership); Local Public Health (Local Health Departments); Healthcare (Healthcare association/society, Private health system, University student health); County Government (County Management, County Social Services); Business (Real estate, Retail shop, Coffee shop, Technology company); Community Organization (Recreation & youth programming, Food distribution); Transportation (City Transportation, State Transportation).
†Based on 2013 Rural Urban Continuum Code (RUCC) classification scheme; RUCC<4, metropolitan.

Interview procedures

Three members of the study team (KTJ, MDP, KHL) developed the semi-structured interview guide following a review of decision theory literature and iteratively revised it

during the first three interviews (Supplemental Appendix 1). One member of the study team (KTJ), a graduate research assistant with qualitative interview experience and visible racial and gender privilege, conducted semi-structured interviews using a secure web-based video-conferencing platform. All 45–60-min interviews were recorded and transcribed by an external audio to text automatic transcription service. Transcripts were cleaned and de-identified by members of the study team prior to analysis. Interviews were conducted between October 2020 and January 2021, during which North Carolina experienced a surge in cases, with daily COVID-19 hospitalization counts increasing from ∼900 in early October to almost 4,000 in January. North Carolina began administering vaccines in mid-December 2020, however widespread distribution did not begin until late-January (18).

We asked interviewees about their perceived individual and organizational roles in the COVID-19 pandemic response. Interviewees were then prompted to reflect on the key decisions that their organizations made in response to the COVID-19 pandemic in the first two months (February and March 2020) and at the time of the interviews (October 2020 through January 2021), including decisions they anticipated having to make in the near future. In discussing each key decision, we probed interviewees on the other stakeholders (within and across sectors) influencing or contributing to their decision-making process. Interviewees were also asked about the decision-making context (e.g., community beliefs), inputs (e.g., data and scientific guidelines), and processes (e.g., decision-making systems) used by their organizations. Responses to these questions were analyzed and reported separately (*manuscript under review*). This study was determined to be exempt from review by the UNC Institutional Review Board (#20-2087).

Qualitative analysis

We employed conventional content analysis to derive themes from the qualitative data (19). Using an inductive, iterative coding approach, we outlined a general codebook structure stemming from the semi-structured interview guide (Supplemental Appendix 1). We allowed interview codes and themes to emerge as two independent researchers (CBB, KTJ) coded each transcript using MAXQDA software (see Supplemental Appendix 2 for final codebook) (20). We analyzed excerpts within each code relating to the decision landscape (decision-making process codes analyzed separately), identifying major and minor themes. Decision-maker roles were coded to describe the individual's role in the organization, broadly speaking, as well as their role in the organization's pandemic response. Decisions identified by stakeholders were coded as belonging to one or more emergent categories: continuing/suspending in-person services, safety protocols, population served, testing/tracing, vaccination, physical resource allocation, human resource allocation. Within each decision category we analyzed excerpts by sector, identifying key decisions and documenting the interrelationships between decision topics across sectors. To explicitly analyze the interrelationships across sectors resulting from collaborative decision-making processes, we coded for examples of collaboration between organizations, defined as either mutual (both organizations benefitting) or dependent (one organization relying on another for either resources or information). We defined collaboration broadly as two or more entities involved in a joint venture or decision-making process (21, 22). Further, we coded for instances in which interviewees described perceiving the behavior of other local organizations and institutions as indirectly influencing these decisions, another form of interrelationships between stakeholders. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist was used to guide our reporting of the qualitative analysis and results (23).

Network mapping and analysis

We used Kumu, an online platform for organizing complex data, to develop a network map of within- and cross-sector organizational collaboration that formed in response to the COVID-19 pandemic in North Carolina, as described by the decision-makers we interviewed (24). Network mapping is a complex systems method intended to describe and visualize the roles, power dynamics, and relationships between stakeholders in a bounded system (25, 26). Using data from the collaboration codes described above, we first developed a matrix (with sectors along each axis) detailing all instances of collaboration described in interviews. We then inputted this information into Kumu, with organization types as nodes (color-coded by sector) and collaboration illustrated through connections (between two or more nodes). After building the full network map, we used functionality within Kumu to calculate two network metrics: *degree* and *closeness*. *Degree* is a measure of the total number of unique connections attached to each node and is used for identifying frequently-connected local organizations, or hubs, in the network. *Closeness*, quantified on a scale of 0–1, is a measure of how close each node is to other nodes in the network, accounting for the entire network structure, rather than only direct connections (as is the case with *degree*) (24).

Study results

Of the 44 stakeholders interviewed, the majority represented organizations serving constituents within a single county (primarily metropolitan), and constituencies ranged from several hundred to over 1 million (Table 1, Supplemental Table 3). As key informant interviewees provided

organizational perspectives, individual characteristics could not be disclosed. Themes (presented below) emerged within each of three domains comprising the COVID-19 pandemic response decision landscape: (1) Perceived organizational roles, (2) Key decisions, and (3) Interrelationships between organizations (Table 2). These themes describe who was involved in making and informing decisions, in what context decisions were made, and the complexity of this decision landscape across sectors.

Perceived organizational roles

Interviewees' perceived roles in the COVID-19 pandemic response informed the set of relevant decisions their organizations faced and how they balanced inherent competing priorities (e.g., constituent, staff, and community safety; physical, social, and emotional wellness) in the decision-making process (Table 3). Across all sectors, interviewees described the responsibility of continuing to run their organization's operations within the new legal and safety constraints of stay-at-home orders and mandated safety protocols. Non-profits, religious organizations, and county governments underscored the heightened need for their social services, viewing their role as responding to the social and economic consequences of the pandemic. Education and transportation similarly recognized the necessity of their services and viewed their role as ensuring these services were delivered in an altered form to ensure community safety. Healthcare associations saw their primary role as convening organizations for the purposes of knowledge sharing, personal protective equipment (PPE) allocation, and advocacy to the state. LHDs and emergency management had more central roles in the pandemic response, with communicable disease management and crisis response being core functions of these respective entities. County emergency management and LHDs worked together, with LHDs leading the local public health response and emergency management facilitating communication and logistics. Though the extent to which COVID-19-related roles departed from traditional organizational responsibilities varied by organization, the following themes emerged across sectors.

Necessity of balancing established organizational mission with newly imposed responsibility for employee/community safety

Interviewees from all sectors prioritized customer, constituent, and community safety, often as a new responsibility in addition to their originally stated missions. For example, an interviewee from a non-profit dedicated to youth and recreational programming emphasized the challenge of carrying out this mission when they could no longer bring the community together in-person. In this case, the organizational mission and the responsibility for community safety were viewed as being in tension with one another; however, other interviewees viewed keeping their constituents safe as consistent with their original organizational mission, which became *"more urgent than ever before"* (R1, Religion). This responsibility also extended to the health of the broader community. *"The safer we are here, the safer folks are in the community"* (R2, Religion).

Navigating organizational vs. individual responsibility for reducing COVID-19 transmission

Given that many COVID-19 safety protocols required individual behavior change, interviewees acknowledged the limitations of their organizational roles in enforcing these measures. However, they underscored their role as being to educate and empower the public to uphold their personal responsibilities in mitigating COVID-19 spread. "*It's a personal expectation, one, to protect yourself, and two, to comply with it...Our job was really to empower and inform as well as make available resources*" (PS7, Public Safety). One pastor disseminated educational videos to combat misinformation—"*This is a collaboration and God will help us, but he does not dissolve us of our own responsibilities for ourselves*" (R4, Religion). The form of education varied, from ensuring that public health guidance was widely available to tailoring guidance to communities. Interviewees emphasized the importance of ensuring that constituents understood why public health measures were needed. Empowerment included leadership modeling public health behaviors and securing the resources, such as masks, to support community health-minded decisions.

Key decisions

Fulfilling the roles described above involved decisions related to continuing or suspending in-person services, instituting safety protocols, allocating resources (human and physical), testing/screening, contact tracing, and vaccination. Interviewees described a decision ecosystem in which the consequences of one decision (whether related to viral transmission, economic impacts, or organizational realities) prompted the need for subsequent decisions. Further, given how quickly scientific knowledge and public health guidance were changing, interviewees were constantly faced with new decisions across domains. A full matrix of COVID-19-related decisions described is included in Supplemental Appendix 4 and summarized in Table 3. In analyzing the key decisions described by interviewees across sectors, the following thematic decision categories emerged.

TABLE 2 Decision landscape themes and representative quotations.

DOMAIN (Themes)	Representative quotations
Roles	
Necessity of balancing established organizational mission with newly imposed responsibility for employee/community safety	"*Probably our primary role would be to find a way to continue to serve the population in a safe way. That's I think our primary response is how can we continue to serve, but in a way that is safe and gives confidence to folks to be able to continue some of the necessities of like, I mean we did a lot of essential service work, we do a lot of work for essential service employees. And so, we have to figure out how to serve that niche in a way that is safe and responsible. And so I would say continuing our service in a way that continues to protect the people we serve.*" *(NP3, Non-profit Org.)*
Navigating organizational vs. individual responsibility for reducing COVID-19 transmission	"*So I was challenged with the task and the responsibility of putting out videos and contacting the community asking them, "No. Hey listen, this is very serious." And as a community leader here hoping against hope that they took me seriously. I also had to address some erroneous thinking on their part especially the thinking of, "I'm going to put my faith in God and I'm going to let God take care of me." . . . We don't place our responsibility on God. This is a collaboration and God will help us, but he does not dissolve us of our own responsibilities for ourselves." (R4, Religion)*
	"*Our role became in an education and empowerment bent. It's a personal expectation, one, to protect yourself, and two, to comply with it. To have the right tools and understand the systems and systems can have number of connotations, but the systems that impact you on a macro level, our job was really to empower and inform as well as make available resources." (PS7, Public Safety)*
Key decisions	
How to translate public health guidance into given organizational context	"*I closed the interior of the space for 5 months, set up at the front door a walk-up counter... And I kept it that way much longer than the governor required, just because I needed to be confident that I could keep everyone safe, and that people were on board with protecting one another and not just adhering to some rules that I established . . . but wanting to be on the same team with protecting one another. It took a while to get there." (B4, Business)*
When to institute, or loosen, public health restrictions	"*. . . through contact tracing and through our case investigation, we started also identifying some hotspots where we started seeing patterns in transmission. . . based on that data, we mobilized our testing resources out there to be able to provide onsite testing to reach a broader, wider number of people and maybe people that wouldn't have necessarily come to our facility to be tested. . . " (PH2, Public Health)*
How to holistically address downstream pandemic impacts	"*. . . early on, especially in March, the decision was a health risk-based decision. How many people can we save from being sick? . . . But I think now, the decisions that are being made are more about the social disruption. And by that, I mean, the economic disruption. This pandemic is costing us lives, yes. But it is costing us financial well-being, and mental health well-being and all those other well-beings, right? Especially in college age individuals. For college age individuals. . . they're not getting the health impacts that the 60 and older age group is facing... They're getting the life disrupters." (H5, Healthcare)*
Interrelationships	
Necessity of collaboration between organizations and stakeholders across sectors	"*. . . we have this local company that's been here for almost 100 years, that charter, they do charter buses for weddings and for high school football games and things like that. . . So they were really close to going out of business, they had laid off pretty much all of their staff. And so when the city contacted them and said, "Hey, would you be willing or interested in helping us drive transit?" . . . And so very quickly, they pivoted and trained with us in like a week and learned our transit system, and were picking up passengers and charter buses. . . it ended up being a very mutually beneficial situation. And I think the city saved them from going out of business and they really saved a lot of our riders too." (T1, Transportation)*
	"*Our EOC [Emergency Operations Center] was activated and we pulled in all your typical emergency services but then we stood up a health and human services branch that specifically focused on food insecurity, sheltering, and business recovery. Those were three big pieces out of the emergency operations center that we developed inter-agency working groups. It wasn't just city, it wasn't just the county. It was using volunteer organizations, faith-based organizations, non-governmental organizations and using their expertise, using their manpower, personnel, and the resources they could bring to help this entire thing together." (PS3, Public Safety)*
	"*It was more or less like our emergency management partners, who have been fantastic partners, recognizing how big this was going to become, and talking with their partners in emergency management throughout the state, and particularly throughout the region, and really seeing where other counties were stubbing their toes, and just saying, "Hey, you need to be concentrating on public health, and allow us to deal with the frame. We'll continue to work together with the understanding that nothing that we can do, pretty much, can be done without you giving us the okay because this is a public health pandemic." (PH1, Public Health)*
Centrality of local health departments in the local pandemic response	"*We have our health director, she's basically responsible and she's the information liaison if you will for COVID-19. We, me and the board, we weren't out trying to vet the data or peer review it or any of those kind of things. But our health director was taking the data she received from the CDC, she was taking the information she received from the North Carolina Department of Health and Human Services, she was taking the models that they were using to create the guides that they were giving. We took them to be trusted sources." (G3, Government)*
	"*The challenge for us right now is that everybody wants to reopen. . . so everybody wants us to review their plans. . . .*

(Continued)

TABLE 2 Continued

DOMAIN (Themes)	Representative quotations
	Everybody's trying to figure out a way to maneuver around the restrictions that are out there. And how to make the case for how they can do it better than anybody else can." (PH5, Public Health) "*. . . we're stepping back further up-stream, we're really trying to educate the community. Whether it's standard media like newspapers and TV, with our social media outlets. We are working with our city with a $200,000 project, to work on offering education through our, especially into our African American and Hispanic community, to try to educate them about COVID and to prevent it." (PH3, Public Health)* "*So, we engaged community leaders, which included municipal leaders, superintendents, community college president, our local university, the president and leadership staff, many other leaders. So, we engaged them. We also engaged first responders. We engaged the faith community, other folks who serve in congregant care settings. . . . we did that really early on" (PH2, Public Health)*
Influence of decisions made by surrounding organizations	"*Our science collaborative, our medical informatics specialists have said behavior deprives outcomes. And even as the metrics came through they said, "The metrics are the result of community action." So where, and I think, you know [County] is fairly progressive in that way, and we've been pretty good on mask wearing, all that stuff. And they said to us when [County] opens, when [County] opens, when these others big school districts open, it's going to change the numbers, so get ready for that." (E5, Education)*

How to translate public health guidance into organizational context

All interviewees made decisions to discontinue, or transition remotely, all non-essential in-person services in March 2020, informed by state and local stay-at-home orders. Though this was framed less as a decision, and more as a necessarily cautious response to the uncertainties of the pandemic, it prompted a cascade of decisions related to translating guidance into organizational contexts to maintain services/mission while ensuring employee and community safety. Decisions included distinguishing essential vs. non-essential personnel to inform remote work scheduling, securing PPE for essential personnel, and securing the technology necessary to support remote work. Even LHDs had to make internal staffing and protocol decisions, all while being propelled into a more central role than ever before. "*A big part of my workforce have children. . . How do we work and show up to serve the community while balancing the needs of what you're having to do at home?*" (PH4, Public Health).

In contrast, re-opening decisions were more contentious. While many strove to re-open, some decision-makers remained closed or instituted safety protocols beyond legal mandates. "*I needed to be confident that I could keep everyone safe, and that people were on board with protecting one another*" (B4, Business). However, pressure from community members to re-open grew over time. "*I've watched some of my colleagues at more conservative schools have to make decisions that they weren't 100% comfortable with, in terms of how rooms were organized, in terms of mask use . . . because of the pressure of their community*." (E3, Education).

When to institute, or loosen, public health restrictions

While not all sectors were directly involved in testing, tracing, and vaccination, related decisions made by LHDs and emergency management influenced community transmission, and thus decisions about re-opening and safety protocols by organizations in other sectors. LHDs and EMs instituted contact tracing early on. "*To date, we believe that we maintained a seven-day rolling average of less than a hundred cases a day because we continue to do contact tracing*." (PS4, Public Safety). LHDs and emergency management also implemented testing, often in partnership with external clinical entities; however, interviewees described challenges in carrying out these services equitably at scale. "*Contact tracing in most public health agencies wasn't fit for purpose, for the scale*" (B2, Business).

How to holistically address downstream pandemic impacts

A final category of decisions related to developing new or extending existing services to address social impacts of COVID-19 restrictions, such as homelessness and food insecurity. In some cases, this meant balancing infection risk with health risks of downstream consequences. Interviewees noted a primary tension in that efforts to "*dampen down COVID in our community are also the things that are putting some of our most vulnerable population at risk*" (PH5, Public Health). For organizations working to meet social needs, the recognition of heightened need motivated organization leaders to ensure services continued, even if processes had to change to keep staff, volunteers, and constituents safe. "*There's a whole litany of things that have kept us busier and have really proven the urgency and the significance of community-based and faith-based organizations*." (R1, Religion).

Interrelationships

The complexity and novelty of COVID-19 demanded the pooling of resources and expertise in decision-making,

exemplifying the interrelationships between individuals, organizations, and resources within and across sectors. Given that organizational decision-makers were thrust into new roles and thus faced new decisions and competing priorities in response to the COVID-19 pandemic, they described turning to existing and new collaborations to navigate these complexities. Collaborative decision-making, as well as the influence of decisions made by other organizations on decision-making, showcase the complex interrelationships between individuals, organizations, and resources within and across sectors.

Network mapping results

Figure 1 shows the complexity inherent in the network map developed from the collaboration described by interviewees. Each node in the map represents an organization type, color-coded by sector and sized by closeness metric (larger nodes more connected to other nodes in the network map). Supplemental Appendix 5 presents complete network mapping metrics (i.e., closeness, degree). Additionally, a full, interactive network map can be found online. Hovering over individual connections and labeled loops will provide details about each collaboration represented in the map. Given that interviews were conducted among a small subset of all stakeholders involved in the local pandemic response decision landscape, and that interviews were limited to the most notable decisions interviewees were facing, this network map represents a subset of the connections and complexity involved in the complete decision landscape. Results from the network map, paired with qualitative analysis of excerpts coded as collaboration or the influence of other organizations, led to the synthesis of the following themes.

Necessity of collaboration between organizations and stakeholders across sectors

Interviewees described creatively responding to COVID-19-imposed challenges by forming new, and leveraging existing, collaborations among diverse stakeholder to prevent blind spots in decision-making. Three main categories of collaboration were identified: (1) **Public—Public**, particularly within sectors of local government (e.g., public health and emergency management co-leading the local pandemic response), (2) **Public—Private**, particularly government-initiated collaboration with non-governmental organizations (e.g., county social services partnering with community organizations to distribute COVID federal relief funds), and (3) **Private—Private**, particularly among businesses, non-profits, and religious organizations (e.g., local businesses partnering to deliver care packages to frontline workers). Interviewees universally described feeling that their collaborative capacity became stronger because of COVID-19, "*One of the positives that's going to come out of COVID is that we're going to have a more robust, cohesive, collaborative model of non–profits and organizations working together*" (R1, Religion). As measured in both *degree* and *closeness*, LHDs, healthcare systems, and county management were the most central actors in the decision landscape, documenting the high frequency with which they collaborated with other organizations in response to COVID-19 and their central role (Supplemental Appendix 5).

Centrality of local health departments in the local pandemic response

LHDs in our network map had a total of 24 unique connections (*degree*) and the highest *closeness* metric of 0.867 (Supplemental Appendix 5). As *closeness* is measured on a scale from 0 to 1, a *closeness* metric of 0.867 suggests that, of the organizations included in our analysis, LHDs had the most direct and indirect connections to other organizations in the network map. The next highest *closeness* metric was 0.633 (healthcare systems). On the whole, *closeness* metrics ranged from 0.356 to 0.867 with a mean of 0.51".

Central to many of the interrelationships described by interviewees, LHDs served a critical function in the pandemic response, both informing local decision-making and facilitating the implementation of higher-level decisions through collaboration with other sectors impacted by those decisions. LHDs served four primary collaborative roles: (1) Directly responding to the communicable disease outbreak (e.g., testing, tracing, vaccination); (2) Guiding the translation of public health guidance into local organizational contexts; (3) Educating the public; (4) Convening and engaging community stakeholders (Figure 2). Implementing a comprehensive pandemic response required collaborating with other sectors, such as hosting testing and vaccination events in parking lots. As described by an interviewee whose church volunteered as a test site, "*…the fourth Saturday of the month, for as long as they want, this will be the test site here. That's one of the ways that we're trying to help folks in the community*." (R2, Religion). LHDs informed decisions at the crossroads between federal- and state-level guidance (e.g., mask mandates, distancing guidelines) and local organizations. They were viewed as "trusted sources" (G3, Government), providing tailored public health advice, visiting local businesses, and reviewing safety protocols. Educating the public required monitoring and reporting local COVID-19 trends through data dashboards and collaborating with leaders from other sectors to host press conferences and conduct educational campaigns. Lastly, LHDs were tasked with convening and connecting stakeholders across sectors to ensure the inclusion of diverse perspectives in addressing the economic and social determinants of health, creating *"better health through better partnerships"* (PH3, Public Health).

TABLE 3 Organization roles and key decisions among interviewees ($N = 44$).

Sector (Organizations represented)	**Perceived role(s)**	**Representative decisions**
Business (Real estate, Retail shop, Coffee shop, Technology company)	Continuing to meet original business mission while taking responsibility for keeping customers safe	Closed shop to public and built online business (Retail) Masking, distancing, and sanitizing requirements for customers and staff (All) Worked with governments and shipping companies on optimization (Tech)
Non-profit organization (Recreation & youth programming, Food distribution)	Managing operations and risk management; tension between increased need for services and the responsibility of keeping staff, volunteers and clients safe	Suspended ancillary services (e.g., education) to focus on food distribution (Food) Updated volunteer safety protocols in response to changing CDC guidelines (All) Convened non-profits to support virtual learning (Rec)
County government (County Management, County Social Services)	Ensuring the safety of staff and direct clients; anticipating community needs stemming from COVID-19 economic impacts	Implemented safety protocols for in-person county staff (All) Created new position to oversee food delivery for kids at home (SS) Leased new building to accommodate social distancing (Mgmt.)
Healthcare (Healthcare association/society, Private health system, University student health)	Healthcare associations: Convening organizations for knowledge sharing, PPE allocation, and advocacy to the state. Health system/Student health: Ensuring the safety of providers and patients, with an emphasis on PPE allocation and COVID testing	Championed stay-at-home policy in the community (Health System) Ensured continuity of care for students leaving campus (Student Health) Created PPE group purchasing system (Association)
Public health (Local health departments (LHDs)	Limiting disease spread (testing, tracing, vaccination); Guiding the translation of public health guidance into local organizational context; Educating the public; Convening and engaging community stakeholders	Issued stay-at-home order and mask mandate in advance of the state Reviewed safety protocols for local organization re-opening plans Orchestrated strike teams to address homelessness and food insecurity
Public safety (County emergency Services/Management (EM), County Sherriff's Office)	County emergency management: Facilitating communication and logistics for the public health pandemic response. County sheriffs: Ensuring the safety of staff and people under the care of law enforcement; enforcing executive orders	Decreased number of arrests to reduce detention center volume (Sherriff) Issued warnings for businesses not following protocol (EM) Forecasted PPE needed to run emergency operation center (EM)
Religious Org. (Churches)	Meeting the social and safety needs of church members and the broader community; being a source of trusted leadership; continuing to instill hope in community	Suspended (and in some cases, later resumed) in-person religious services Identified gaps in community social services and worked with other groups to meet those needs Partnered with LHD to host testing event
Education (Universities, Community college, Private & public grade schools, School board)	Promoting the well-being of students through continuing education; meeting social needs of students' families and surrounding communities; ensuring student safety	Transitioned to remote learning (All) Hired COVID coordinators at each school responsible for temperature and symptom checks (Primary, Secondary) Delivered laptops and hotspots to students (Primary, Secondary)
Transportation (City Transportation, State DOT)	Ensuring safety of citizens while using public transit, public spaces, and roadways	Transitioned public input sessions to be virtual (All) Hired private transportation company to supplement/avoid cutting routes (City) Lent businesses public space for outdoor dining (City)

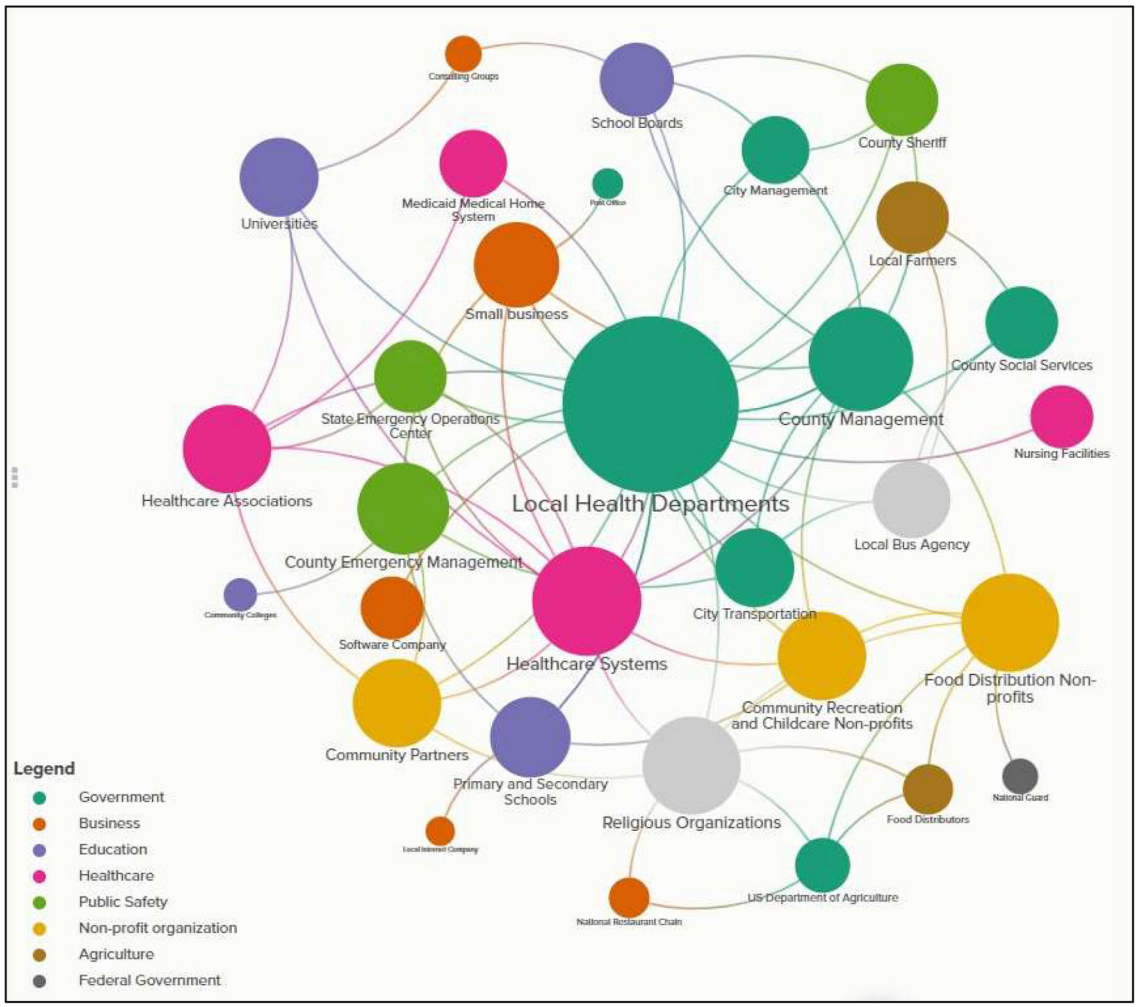

FIGURE 1
Network map of cross-sector partnerships formed in North Carolina's local COVID-19 pandemic response. This figure shows the network map developed from the collaboration described by interviewees. Each node in the map represents an organization type, color-coded by sector and sized by closeness metric (larger nodes more connected to other nodes in the network map). A full, interactive network map can be found (24).

Influence of decisions made by surrounding organizations

Beyond the interrelationships resulting from explicit cross-sector collaboration, interviewees also described the impact of decisions made by the public and other surrounding organizations. As one interviewee noted in reference to the influence of community mask compliance and school district re-openings, *"metrics are the result of community action… If we change our behavior, it's going to change the numbers"* (E5, Education). In addition to influencing COVID-19 transmission trends, local decisions were described as influencing the feasibility of asking employees, volunteers, or customers to return in-person (e.g., Are schools open to provide childcare? Is public transportation running at full capacity?).

Discussion

The COVID-19 pandemic has thrust decision-makers across sectors into new roles in a public health crisis response, creating a decision landscape with numerous actors and varying levels of coordination between them. Qualitative inquiry and network mapping and analysis allowed us to examine this cross-sector decision landscape through a complexity/systems thinking lens. The pandemic has forced the development of new decision-maker roles and competing priorities that decision-makers have navigated with limited, uncertain, and changing information. In response to the complexity of COVID-19, decision-makers engaged in both collaborative and semi-autonomous decision-making processes and depended upon new authorities,

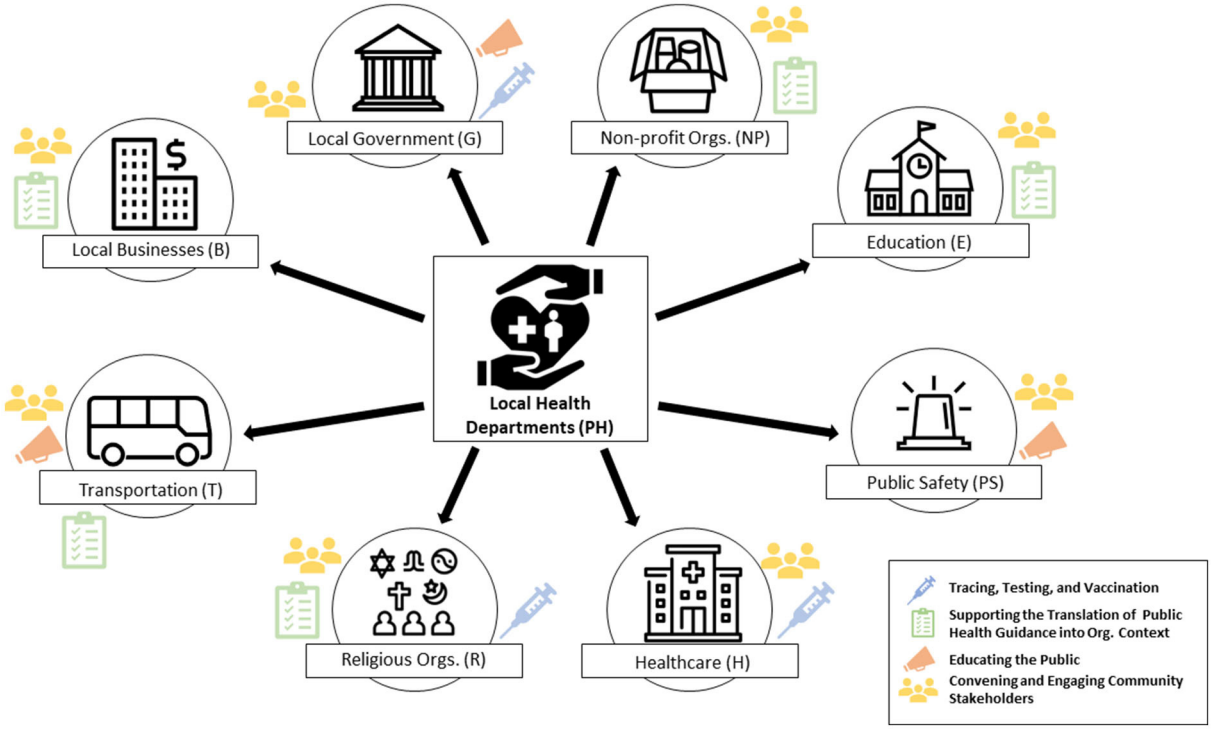

FIGURE 2
Central roles of local health departments in coordinating local COVID-19 pandemic response across sectors.

especially LHDs. In this resulting "polycentric" decision-making system, public and private actors worked across different centers of decision-making and at different scales to collectively produce their community's health during the pandemic (27). This study serves to (1) inform public health researchers, practitioners, and organizational decision-makers in how to navigate this and future complex, cross-sector population health challenges, and (2) illustrate a replicable approach to mapping and characterizing complex decision landscapes.

This study builds off prior work highlighting cross-sector responses to crises such as Hurricane Katrina and H1N1 (28, 29). It also extends prior applications of network mapping to other complex health challenges, such as serious mental illness (26) and community health promotion networks (25). However, this study is the first, to our knowledge, to use network mapping to investigate a cross-sector decision landscape in response to COVID-19. Several prior studies have investigated decision-making in response to COVID-19 within single sectors. These studies support the decision categories that emerged from our analysis, including decisions related to allocating resources (30), translating guidance into real-world organizational context (31), and addressing downstream social impacts (32). Our finding that cross-sector collaborations were critical components of the COVID-19 pandemic response builds upon several prior studies illustrating specific collaborations emerging in response to COVID-19-related needs, ranging from childcare for healthcare workers to local COVID-19 surveillance through school districts (33–36).

In line with our findings, prior work has emphasized the importance of community engagement in comprehensive pandemic responses and the necessity of communicating well (e.g., using accessible yet accurate language) with diverse stakeholders amidst changing, uncertain information (37). Challenges with community-based approaches, however, include balancing the need to respond quickly with the time it takes to meaningfully garner stakeholder perspectives (38). The need to navigate complex tradeoffs and often conflicting priorities within a community further underscores the importance of a cross-system governance or organizing structure with input from many stakeholder groups (32). Given the need to act quickly, communities should agree on such structures in advance of public health crises. Our analysis highlighted the importance of LHDs serving as what "Public Health 3.0" defines as a "chief health strategist" in coordinating the local pandemic response (39), working with other organizations directly and indirectly to govern the local public health system (40).

The decision landscape emerging in response to COVID-19 has implications for efforts to promote population health, beyond the immediate context of COVID-19. Though a global

pandemic uniquely affects all individuals and organizations, other population health challenges operate within complex systems, influenced by multi-level determinants, ranging from individual action to social policy (41). This can create inconsistent priorities and decisions within communities that block progress. The role of stakeholders across sectors in the pandemic response, and the interrelationships between these sectors, support the growing call for the importance of cross-sector collaboration in promoting population health (7, 42, 43). Our findings further align with the vision of "Public Health 3.0" to expand the reach and scope of public health to "address all factors that promote health and well-being, including those related to economic development, education, transportation, food, environment and housing" (39). Public health leaders advocating for this broadened definition of public health have underscored that carrying out this vision successfully requires sustainable cross-sector collaboration, community engagement, and the application of a systems perspective to problem solving (44).

The "10 Essential Public Health Services", updated in 2019 to include a focus on health equity, also reflect this reality, which considers the public health system to include not only public health agencies and healthcare providers, but also public safety, human services, and education, among other sectors (45). The decisions described in our analysis broadly fall into the three core domains of the essential services of public health: assessment (e.g., contact tracing, testing), policy development (e.g., implementation of executive orders, mobilizing community partnerships, educating the public to support effective policy change), and assurance (e.g., workforce maintenance, ensuring equitable access to services) (46). However, the COVID-19 pandemic has showcased that the centrality of equity in the revised essential services may still be aspirational. Disparities in COVID-19 morbidity and mortality rates by race and socioeconomic status underscore the need for system-wide decision-making that better prioritizes equitable access to health services, ranging from healthy living conditions to clinical care (47, 48). Additionally, the pandemic has highlighted the importance of the essential service, to "build and maintain a strong organizational infrastructure for public health," moving forward (46). Bringing together the many sectors involved in the United States' fragmented public health system effectively and sustainably, beyond the immediate aftermath of a crisis, requires local foundational infrastructure supporting timely and comprehensive data collection (49); flexible funding mechanisms that recognize the necessity of cross-sector work in public health (50); and sufficient staffing capacity, particularly in response to the burnout of the current public health workforce (51, 52).

These findings should be viewed in the context of several limitations. While we were intentional in ensuring diverse representation of interviewees across sectors, organization type, and geography (across North Carolina), the sample does not represent an exhaustive list of organization types involved in the COVID-19 response. In all complex systems work, how system boundaries are defined has the potential to influence findings (8). Though we defined the bounds of the system under study based on geography (North Carolina) and organizational decision-makers, this system is too large to have a formal roster of all stakeholders involved. Results may have been different had we focused on a single community (region, city, or county) within the state, which would have allowed us to gain a more complete understanding of all stakeholders and their interactions. The snowball sampling technique employed increases the potential that the opinions uncovered were more homogenous than they would be otherwise. However, we were explicit when asking for recommendations that we were interested in uncovering a more complete and broader perspective on the subject. Thematic saturation was based on generalizable themes that emerged across sectors. Future research should investigate specific instances of cross-sector collaboration in more bounded systems, interviewing a complete roster of stakeholders involved, to gain a more detailed understanding of the role of power dynamics and competing priorities in influencing system dynamics. We hope that this study, which sought a broad boundary, will inform and standardize future efforts to study complex decision landscapes across diverse communities to learn what is similar and distinct.

The timing of interviews with respect to official guidance, transmission rates, and vaccination rollout undoubtedly influenced participant responses. We incorporated timing into interviews and analysis. Additionally, participant responses may be subject to self-report bias, given limitations of recall and the potential for selective reporting. As interviews lasted no more than an hour, it is not feasible to expect interviewees to recount every decision involved in their organization's pandemic response. As such, we asked interviewees to prioritize the key, COVID-related decisions that they perceived to be most important to their organization. Lastly, decision-makers willing to participate in public health research may have differed from those who refused in the extent to which they valued and trusted scientific information. However, participants described a range of perspectives on how they incorporated scientific information into decision-making.

This network mapping qualitative analysis of local decision-makers from nine different sectors in North Carolina documents the complex, cross-sector local decision landscape in response to the COVID-19 pandemic. Most notably, this analysis highlights the expanded roles of decision-makers across sectors in the pandemic response, the key types of decisions faced, and how decision-makers relied on collaboration and the guidance of LHDs to respond to these new challenges. Understanding this decision landscape serves to inform public health researchers and practitioners about who is involved in decision-making related to community health and how. Knowing this can

support communities in collaborating to improve organizational decision-making processes with community and population health in mind. It also underscores the need for public health infrastructure to improve information dissemination, priority setting, and alignment in response to future crises and other complex health challenges.

Data availability statement

The datasets generated for this study are not publicly available due to data confidentiality. Investigators interested in accessing this dataset for future research may do so under the following conditions: (1) IRB approval has been obtained from the institution covering the investigator, (2) data security procedures ensuring patient privacy have been demonstrated by the investigator, and (3) a data use agreement is completed by UNC and the outside investigator. Final datasets for analysis will not include any identifying information.

Ethics statement

The studies involving human participants were reviewed and approved by UNC Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

Data curation: CB and KJ. Formal analysis: CB, KJ, and HH. Funding acquisition: MP, MM, JS, and KH. Investigation: KJ and KH. Methodology: CB, KJ, MP, and KH. Project admin: KJ. Supervision: MP and KH. Validation, visualization, and writing–original draft: CB. All authors contributed to the conceptualization of this study, writing–review and editing, and approved the submitted version.

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Conflict of interest

JS reported receiving compensation from Georgia Institute of Technology and Zoetis, Inc. in the prior 12 months.

The remaining authors declared that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.906602/full#supplementary-material

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Corruption in the health sector: A problem in need of a systems-thinking approach

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Health systems are comprised of complex interactions between multiple different actors with differential knowledge and understanding of the subject and system. It is exactly this complexity that makes it particularly vulnerable to corruption, which has a deleterious impact on the functioning of health systems and the health of populations. Consequently, reducing corruption in the health sector is imperative to strengthening health systems and advancing health equity, particularly in low- and middle-income countries (LMICs). Although health sector corruption is a global problem, there are key differences in the forms of and motivations underlying corruption in health systems in LMICs and high-income countries (HICs). Recognizing these differences and understanding the underlying system structures that enable corruption are essential to developing anti-corruption interventions. Consequently, health sector corruption is a problem in need of a systems-thinking approach. Anti-corruption strategies that are devised without this understanding of the system may have unintended consequences that waste limited resources, exacerbate corruption, and/or further weaken health systems. A systems-thinking approach is important to developing and successfully implementing corruption mitigation strategies that result in sustainable improvements in health systems and consequently, the health of populations.

KEYWORDS

corruption, global health, health systems strengthening, systems-thinking approach, low- and middle- income countries (LMICs)

Introduction

The health sector is a dynamic system composed of complex interactions between patients, providers, payers, suppliers, and policy makers. It is exactly this complexity that makes it particularly vulnerable to corruption. Corruption, commonly defined as the "abuse of entrusted power for private gain," (1) is a problem within health care systems globally. However, it is important to note that "corruption" not only encompasses actions that are illegal in most countries, but also those that could reasonably be considered unethical, and when pervasive, weaken and foster distrust in the health systems.

Corruption takes many forms within the health sector and occurs at all organizational levels from government agencies to the direct provision of care. Likewise, the motivations underlying health sector corruption vary by country. Therefore, it may be challenging to adapt corruption-mitigating strategies that were successful in one health system to another system with completely different incentives, accountability structures, enforcement mechanisms, and socio-economic and political contexts. Given the heterogeneity and dynamic nature of health systems, sustainable reductions in corruption and resultant improvements in health care delivery require a systems thinking approach.

In order to understand the scope of corruption, its impact on population health and health systems will be reviewed. This will be followed by an overview of common types of health sector corruption with special attention paid to differences in manifestations of and motivation and policies underlying corruption in high-income countries (HICs) and low- and low-middle-income countries (LMICs). The second section will review select anti-corruption strategies that have been implemented in LMICs through systems-thinking lens and how a systems-thinking approach could be utilized to address health sector corruption, particularly in LMICs.

Impact of corruption on population health and health systems

Pervasive corruption has the potential to impact the health of populations. Countries with high levels of corruption spend less on health care as a percentage of gross domestic product (2, 3). In addition, high levels of corruption correlate with poor health-related outcomes. This includes higher infant and child mortality rates (4, 5), lower life expectancy (2, 5), lower immunization rates (6), and higher rates of antibiotic resistance (7). Moreover, corruption has a negative effect on the mental health of citizens, with individuals who experience high levels of corruption reporting a lower perception of their overall health (8, 9).

Corruption impacts health systems as well. In 2019, the U.S. government recovered $3.6 billion USD in health-related fraud judgements and settlements (10). However, this likely represents the tip of the iceberg of fraudulent activities in U.S health system, which is estimated to lose $58.5–83.9 billion USD annually to fraud and abuse (11). This trend is also reflected in global estimates of health care spending, where at least 7% is ceded to corruption, an estimated $500 billion USD (12). These data suggest that commitment of financial resources may have a diminished impact on the health of populations if they are being diverted for corrupt purposes.

Lastly, corruption is particularly problematic because of who is most affected. Previous studies have shown that corruption impacts the most vulnerable patients regardless of country. Individuals who are in poor health (13) or are at high socioeconomic risk (3, 14) are more likely to make informal payments. Data from sub-Saharan Africa suggests that individuals who reported paying bribes for health-related services were 4 to 9 times more likely to also report difficulty accessing health care (15). In the United States, nearly 790,000 Medicare beneficiaries over a 3-year period were treated by providers who were subsequently found to have committed fraud and abuse violations (16, 17). These beneficiaries were more likely to be non-white, dually eligible for Medicare and Medicaid (suggesting lower income), and disabled (16).

These examples highlight the deleterious impact of corruption on population health, health systems, and addressing health equity. Consequently, tackling corruption within the health sector is imperative to strengthening health systems. Understanding the forms of health sector corruption is an important first step in these mitigation efforts.

Manifestations of corruption in health systems

In order to understand manifestations of health sector corruption, it is important to be familiar with actors in health systems and their relationships to one another. The exact actors vary from country to country, but roles within health systems can be characterized based on a continuum of service delivery (Figure 1). On one spectrum of health systems, furthest removed from direct provision of services, are governments and the government officials who are responsible for crafting health-related policies, executing the policies, and regulating the health system. At the level of direct service delivery are the health care workers who provide services (e.g., physicians, nurses, pharmacists, etc.), and patients who are the recipients of those services. In between the actors involved in policy and regulation and those involved in the direct provision of care are the payers and suppliers. Payers fund the health system and, depending on the country, may be government agencies, non-profit or for-profit insurance companies, or patients themselves. Suppliers are those that provide the infrastructure and environment for health care to be delivered, e.g., medical device and pharmaceutical companies, equipment manufacturers, etc.) (18). Importantly, corruption can occur at any level and involve any actor within this complex system. The six forms of health sector corruption reviewed in detail here are improper financial relationships, theft and diversion of resources, fraudulent billing, absenteeism, informal payments, and counterfeit medical supplies (summarized in Table 1).

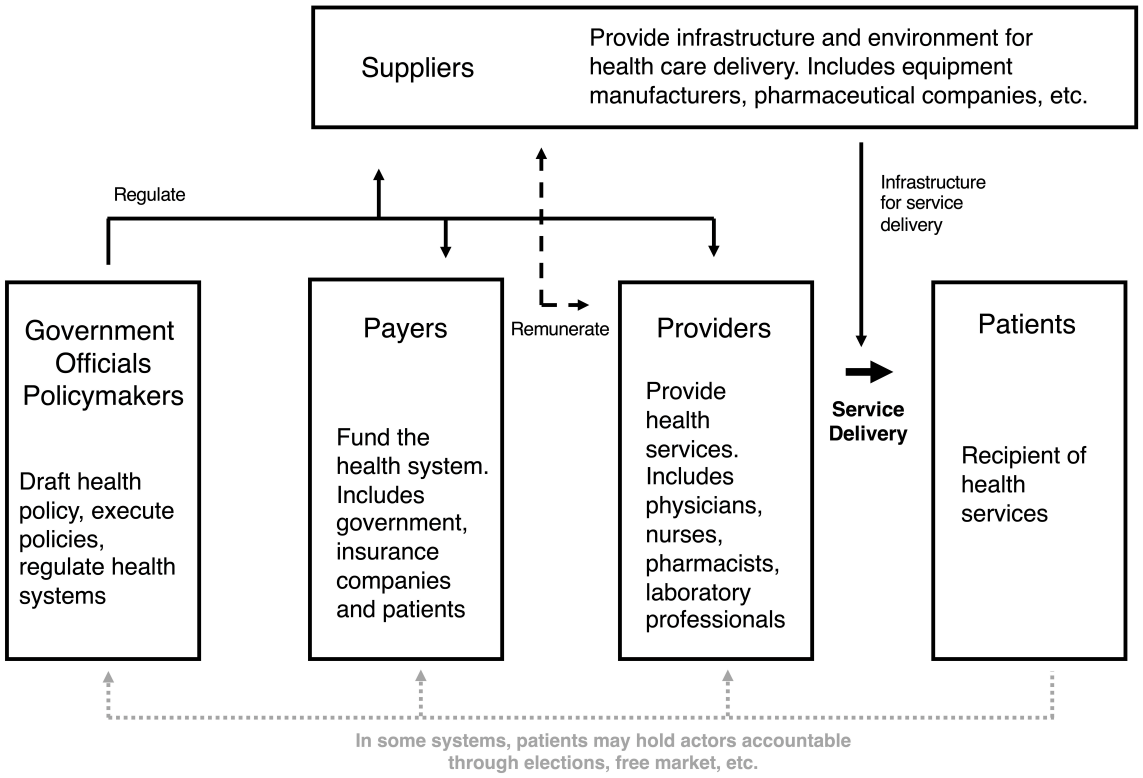

FIGURE 1
Schematic diagram of actors in the health system along the continuum of service delivery.

Improper financial relationships

Improper financial relationships are associations between actors within the health system that have the potential to create a conflict of interest. Specifically, they foster situations where individuals are motivated by financial enrichment over medical indication, patient well-being, and/or public health. At the highest level of service delivery, improper financial relationships can occur between government officials and for-profit entities within the health sector (e.g., pharmaceutical, medical device, insurance companies) (19). Other potential manifestations of improper relationships at the highest level of government include deregulation of the health sector to the benefit specific interest groups, influence over health-related recommendations or guidelines, expediting approval of pharmaceuticals or medical devices, etc. (18, 20).

Improper financial relationships involving providers can also exert inappropriate influence at the level of direct service delivery. Two common business relationships that fall within this category are self-referrals and kickbacks. Self-referrals occur when providers refer patients for medical services performed by an entity with whom the provider or family member has a financial relationship. Although they may be legal, these financial relationships have the potential to result in medically unnecessary interventions or more expensive interventions that financially enrich providers at the expense of patients or payers (21). Kickbacks at the service-delivery level are similar to those at the government or payer level. For example, a pharmaceutical company may pay inducements to providers to preferentially prescribe their company's medication (22).

Fraudulent billing and claims

Fraudulent billing refers to the act of obtaining reimbursement for services or items that were either not provided, more complex than what was provided, or medically unnecessary. The actors involved in fraudulent billing can vary depending on how health care was financed. In countries with social health insurance programs, fraudulent billing occurs primarily between providers and either government or private payers. In countries without well-established health insurance systems where out-of-pocket payments predominate, providers may fraudulently obtain reimbursement from patients. In addition, providers may also defraud the government for services or items related to certain diagnoses, patient populations, or conditions that are provided by government at no charge to patients (HIV, tuberculosis, prenatal or pediatric

TABLE 1 Forms of health sector corruption and the actors who are involved.

Corruption type	Definition	Actors involved	Examples
Improper financial relationships	Relationships between actors within the health system that have the potential to create situations where individuals are motivated by financial enrichment over medical indication, patient well-being, and/or public health	Government officials Payers Suppliers Providers	Provider who receives financial support from pharmaceutical companies that manufacture medications that the provider prescribes to patients at their clinic
Fraudulent billing and claims	Obtaining reimbursement for services or items that were either not provided, more complex than what was provided, or medically unnecessary	Providers Suppliers	Upcoding, seeking reimbursement for a procedure that was not actually performed, unbundling diagnostic testing to increase reimbursement
Theft and diversion	Theft - taking resources to which one is not entitled without consent or permission. Diversion - taking and reselling resources for another purpose without consent or permission	Government officials Payers Suppliers Providers	Taking supplies from a public hospital for use in one's private clinic, diverting medications for resale
Absenteeism	Frequent, unauthorized absences for the purpose of pursuing private business during working hours	Government officials Providers	Taking frequent absences from public sector health center to work in a private clinic
Informal payments	"Payments to individual and institutional providers, in kind or in cash, that are made outside of official payment channels or are purchases meant to be covered by the health care system"	Government officials Payers Suppliers Providers	Soliciting or offering a bribe or gift to shorten patient wait times at a busy clinic, charging more than an official user fee and pocketing the difference
Counterfeit medical supplies	Intentional production and distribution of falsified medical supplies for financial gain	Government officials Suppliers	Bribing government officials to waive required inspections allowing the import of counterfeit diagnostic test kits; selling antibiotics with no active ingredient to patients who cannot afford to pay for the authenticated version

care). Fraudulent billing is a relatively common form of health sector corruption in HICs. In OECD countries, fraudulent billing in the form of overprovision or overbilling for services were among the most common forms of corruption (20, 23, 24).

Theft and diversion

Theft occurs when individuals take resources to which they not entitled without consent or permission. Diversion refers to taking and reselling resources for another purpose without consent or permission. Theft and diversion of resources can occur at all levels of a health system. At the government or payer level, theft often takes the form of embezzlement, where government officials or insurance company employees siphon health-related funding for personal use (20). In addition, large-scale theft of donor funding allocated to LMICs by government officials has also been reported (25).

At the provider level, health care workers may divert supplies, medication, equipment, or official fees for financial enrichment (26–29). The extent of theft and diversion at the provider level is challenging to precisely measure. Relative to other forms of corruption, theft and diversion is perceived to be less common in OECD countries (20). However, qualitative studies from sub-Saharan Africa, indicate that theft may be a larger concern in this region where public health systems have historically been weak (26, 27). Health care workers from multiple sub-Saharan African countries report having personal experience with theft within the health system (26–29) and cite low public-sector salaries and suboptimal working conditions as reasons for theft and diversion (26, 27).

Absenteeism

Frequent, unauthorized absenteeism is regarded as corrupt when public sector workers "choose to engage in private pursuits

during working hours" (12). Although absenteeism can occur at the highest levels of government, this review will focus on absenteeism of health care workers and its impact on the direct provision of care. Commonly cited factors driving absenteeism include low and/or unreliable salaries in the public sector, lack of monitoring and accountability, and substandard work environments that includes demanding workloads partially induced by frequent absenteeism (27, 28, 30–38). Specifically, low and/or unreliable salaries are a major driver of absenteeism. Qualitative studies of absenteeism among public sector health care workers in sub-Saharan Africa illustrate the challenges these individuals face. In Nigeria, public sector health care workers report being unable to cover basic necessities with their salaries, including food, clothing, transportation, etc. (39). Some of these employees report going 1 year without being paid a salary (39).

Poor and/or intermittent remuneration promote absenteeism when health care workers engage in dual-practice, or the provision of clinical care in the public and private sector concurrently (40). Although dual-practice occurs in countries at all income levels (40), it is particularly problematic for service delivery when health care workers are absent from their public sector position in order to provide care in the private sector (27, 39, 40). In many HICs where governance is stronger, the private sector is formalized, and the health systems are well-developed, dual practice is prohibited or well-regulated and therefore less likely to result in absenteeism (40). However, many LMICs have weaker governance structures and health systems resulting in a blurred separation of the public and private sector and weak or non-existent regulation of the private sector. These factors contribute to poor regulation of dual practice and incentivizes absenteeism (40).

Informal payments

Informal payments are defined as "payments to individual and institutional providers, in kind or in cash, that are made outside of official payment channels or are purchases meant to be covered by the health care system" (41). They can involve actors at all levels of the health care system from government officials, suppliers, and providers. Informal payments can be illegal or legal and encompass a broad range of unofficial exchanges including overt bribes, favors, substantial gifts, and payments solicited under the guise of an official transaction or fee (42). Some of the motivations underlying informal payments are similar to those described for absenteeism and theft/diversion, namely, low public health salaries (43–46). In addition, cultural and societal norms around gift-giving (44, 46), the marketization of health care (44–46), and prevalence of bribery in other sectors of society (37) are also cited as reasons for informal payments.

Counterfeit medical supplies

Lastly, counterfeit therapeutics, medical devices, and other medical supplies represent an important form of corruption that disproportionately impacts health systems in LMICs (47). According to a report by the World Health Organization (WHO), 20% of malaria medications, 17% of antibiotics, and 9% of anesthetics/analgesics circulated globally were either substandard or falsified (47). Although these substandard or falsified products were reported in numerous countries of all income levels, the problem is particularly acute in Africa, which represented 42% of the total reports (47). Another study evaluating medications in Latin America identified a negative correlation between the quality medications and the level of corruption within the country (48). It is important to note that while producing and distributing intentionally falsified supplies represents a form of corruption, substandard products may be a result of technical inexperience or weak capacity.

Potential factors giving rise to the circulation of counterfeit medical supplies include poor governance in many LMICs where the regulatory capacity is inadequate to ensure the authenticity of these products (47). This regulation is further complicated by the fact that many of these supplies are the product of complex multinational supply chains. Regulation may be even more challenging in LMICs without a national insurance program and where patients are paying for these supplies out-of-pocket. Moreover, those who are suspicious of the efficacy of the medication or device may be reluctant to voice their concerns out of fear of reprisal from criminal enterprises involved in trafficking (47). As highlighted by these examples, while counterfeit medical products occur in countries of all income level, the reporting available suggests the impact is felt most by patients in LMICs.

Corruption in LMICs vs. HICs

The above examples demonstrate that health sector corruption is a global problem with a heterogeneous presentation. For example, fraudulent billing is particularly problematic in countries with some form of social health insurance. In contrast, while theft/diversion, informal payments, absenteeism, and counterfeit medications are present in the health systems of many LMICs, they are less common in HICs. These distinctions highlight the structural differences between health systems in LMICs and HICs, including differing incentives, regulations, policies, forms of remuneration, resources, etc. Moreover, this heterogeneity underscores the need for a systems-thinking approach to address corruption the health sector.

Although corruption occurs in countries of all income levels, this review will focus on using a systems-thinking approach to understand corruption within the health sector in LMICs for two

main reasons. The first is that the majority of the most corrupt countries according to Transparency International's Corruption Perceptions Index (CPI) (49) are categorized as low-income or low-middle income (50). The second and more relevant reason is that corruption represents an informal institution in many LMICs (51). As with most institutions, corruption becomes self-reinforcing, fostering an equilibrium of continued corruption that is challenging to disrupt (51). For this reason, using reductionist strategies to address corruption within health systems of LMICs is unlikely to result in sustainable improvement and may even further exacerbate the problem.

Applying a systems lens to health sector corruption: Structures beneath the surface

The above forms of health sector corruption represent the tip of the iceberg, the events and patterns that are readily visible to observers. However, effectively and sustainably reducing corruption requires an understanding of what is underneath the surface – the structure of health systems, the political and socio-economic environment, and historical context that drive these visible manifestations of corruption (52). This section will summarize the environmental factors that enable and perpetuate corruption within health systems (Figure 2), with special attention paid to differences in corruption within LMICs and HICs.

Socio-economic factors

Although corruption occurs in health sectors of countries at all stages of economic development, the underlying motivations often differ between HICs and LMICs. As outlined in the previous section, absenteeism, informal payments, theft and diversion, and counterfeit medical supplies are forms of health sector corruption that appear to be particularly problematic in LMICs. When evaluating the determinants of these forms of corruption, recurrent patterns that emerge include low and/or unreliable salaries for health care workers and substandard working conditions in the public sector (22, 28, 30, 32, 34, 38, 43–45). When these factors combine with minimal oversight, corrupt individuals in positions of leadership, and corruption in other areas of society (22, 37, 38, 53) it is unsurprising that corruption represents an institutional reality for health care workers in LMICs rather than a scheme for personal enrichment as is seen in many HICs (54). These differences in motivations require a different framework for thinking about corruption in LMICs in order to develop effective mitigation strategies.

To explore these important differences in motivating factors that inform the type and scope of corruption, Monika Bauhr

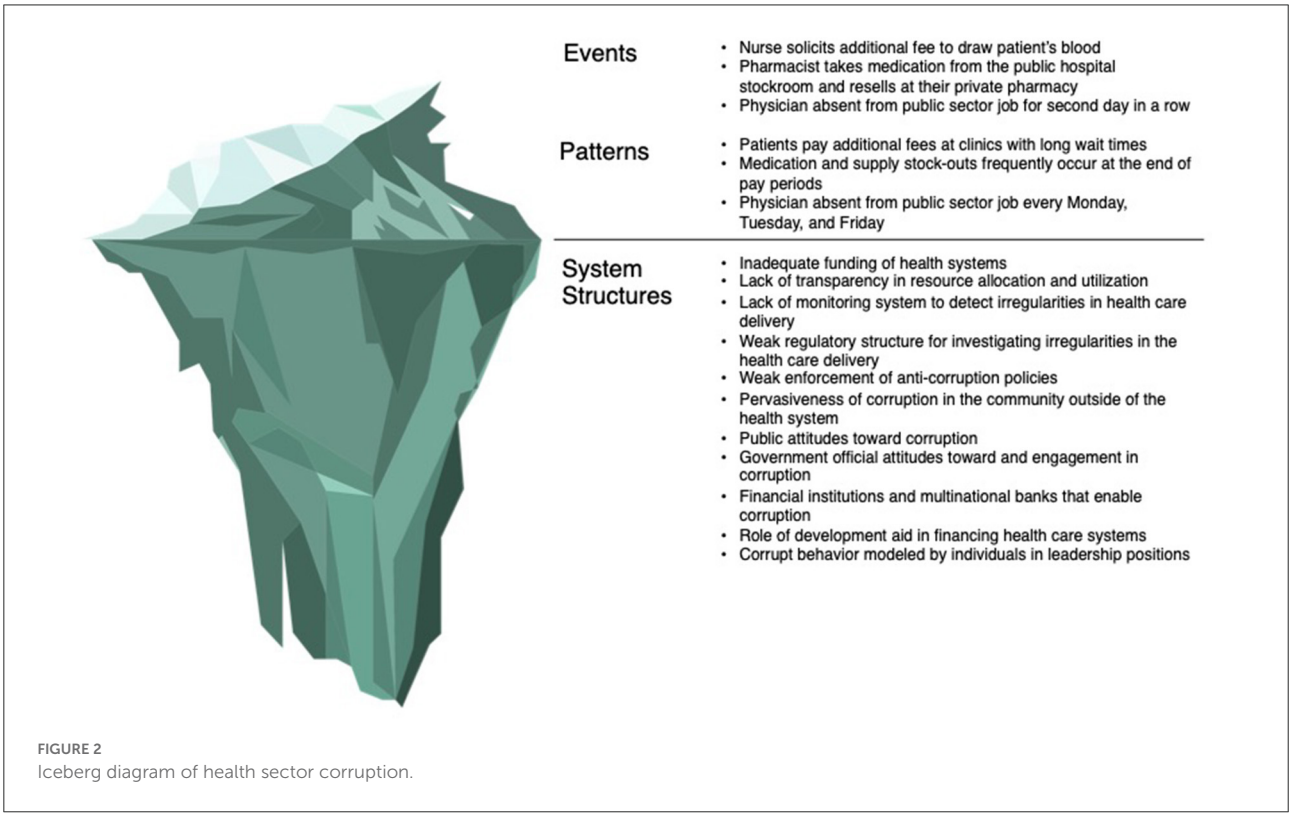

FIGURE 2
Iceberg diagram of health sector corruption.

puts forth a framework of "need" vs. "greed" corruption (54). "Need" corruption refers to acts of corruption that are necessary to carry out in order to access services to which citizens are legally entitled. For example, patients are compelled to make informal payments in order to access health care services that should be provided at no or reduced cost by the government. Health care workers have limited choices but to engage in dual practice or to divert supplies or medications in order to supplement unsustainable public sector salaries. In contrast, "greed" corruption refers to acts of corruption that are carried out by actors for the purpose of personal advantage (54). Embezzlement of health care funds at the government or payer level and some forms of fraudulent billing or improper financial relationships are arguably examples of "greed" corruption.

While greed-based corruption occurs in countries regardless of income level, need-based corruption is relatively uncommon in HICs (54). Moreover, Bauhr suggests that need-based corruption is associated with lower trust in institutions, an observation that was not seen with greed-based corruption (54). Given these differences in the trust of institutions and governments, mitigating need-based and greed-based corruption will require different strategies. There is no doubt that corruption occurs in HICs and may even result in larger financial losses. However, in many HICs, there is an institutional and legal framework for investigating corrupt actors and holding them accountable as well as trust among citizens that this will occur. Understanding these motivators is critical to a systems-thinking approach to reduce corruption in the health sector. Although these institutions may exist outside of the health system and well-beneath surface of the metaphorical iceberg, any anti-corruption strategy must understand the institutional context as they influence the personal and work environments of actors within the health system.

Health systems

Another factor beneath the surface of the health sector corruption iceberg is the strength of health systems in LMICs. A significant barrier to improving health outcomes in LMICs are weak health systems (55). One potential explanation for these weak systems is the wave of structural adjustment programs (SAPs) that were imposed on low-income countries (LICs) by international financial institutions starting in the 1980's (56). These neoliberal policies required heavily indebted LICs, particularly in sub-Saharan Africa, to reduce public sector spending and enhance privatization and deregulation in exchange for debt reduction (57). Some have argued that policies enacted in the health sector to comply with SAPs destabilized public health systems; these policies include cuts to public health resources and/or diversion of resources to the private sector, institution of user fees to access health services, and lay-offs or salary reductions of public sector health care workers (56).

Neoliberal policies represent potential explanation for the weak public health systems that are pervasive in LMICs. These weak systems fail to deliver services to the public and create an environment where the consequences of not engaging in corruption outweigh any potential benefits to holding corrupt actors accountable (58). This relationship between health sector corruption and weakened health systems is essential to addressing corruption in LMICs and may help to explain why anti-corruption strategies developed in HICs may fail to deliver in LMICs. They also highlight how anti-corruption strategies without concomitant investments in strengthening the health sector, may do little to reduce health sector corruption.

Donors and development aid

When considering how to address health sector corruption in LMICs, it is not only important to understand the context of the health system, but also the socio-economic and political environment in which these health systems exist. One important distinction between the environment within LMICs and HICs, particularly when considering financing of health systems, is the role of donors and development aid. From 1990 to 2014, nearly $460 billion USD in development aid was disbursed from high-income to developing countries (59). Donor funding is estimated to represent 30% of health care expenditures in low-income countries (LICs) (12). This proportion is even higher for HIV-, malaria-, and tuberculosis-related care where donor funding of these disease entities is over two times the amount spent by ministries of health (12).

Although investments in the health sector made possible through development aid has saved countless lives, it is important to understand the role of donors within health systems and health sector corruption as development aid continues to be allocated to corrupt countries (60, 61). In sub-Saharan Africa specifically, aid as a percentage of GDP and government expenditure are negatively correlated with quality of governance, even after controlling for GDP per capita (62). Specific to the health sector, approximately $34 million USD of development aid was diverted from the Global Fund (25), leading to significant changes in policies related to transparency and accountability (63). However, it remains to be seen whether these strategies are effective in addressing corruption (63). Therefore, the presence of donors and donor funding adds another layer of complexity to health systems in LMICs. Systems thinking can be utilized to better understand the role of development aid and its interactions with other variables that contribute to health sector corruption.

Applying a systems lens to health sector corruption: Effectiveness of anti-corruption strategies

The evidence indicates that corruption is problem that must be addressed to strengthen the health systems of LMICs. Goals of modern anticorruption strategies include strengthening accountability, detection, and enforcement; improving transparency; and preventing corruption through provision of resources. Examples of strategies utilized to achieve each of these goals are outlined in Table 2. Unfortunately, there is a dearth of strong evidence supporting the efficacy of anti-corruption reforms in the health sector and strongest evidence was for programs implemented in HICs (64). Given the significant differences between health systems in HICs and LMICs highlighted above, it is unclear whether these strategies can be adapted in other settings with the same success. Moreover, many anti-corruption strategies address individual interactions or behaviors, but do not explore how those interactions fit within the context of the system. This section summarizes the effectiveness of three strategies that have been utilized in LMICs to reduce corruption: anti-corruption agencies to strengthen accountability and enforcement, community engagement to improve transparency, and raising public sector salaries to prevent corrupt behavior through provision of resources. These strategies will be reviewed in a systems-thinking context to highlight the limitations of viewing corruption within the health system as isolated linear relationships.

Anti-corruption agencies

In the systematic review cited above, the study that provided the strongest indication of success was a series of legislative and executive efforts in the U.S. aimed at curbing fraud and abuse in Medicare and Medicaid (64). These efforts included formation of an anti-corruption task force with prosecutorial authority and upgrading the analytic capacity for improved detection of billing irregularities (64). As a result of increased detection of fraudulent activities and resultant convictions, the anti-corruption task force was estimated to have recovered $1–3 billion USD per year over the course of 10 years (64).

Formation of independent anti-corruption agencies has also been attempted in LMICs, but with mixed results. For example, in Karnatka, India, an anti-corruption agency underwent a change in scope and leadership in 2001 to address rampant public sector corruption. Under new leadership, this agency uncovered systemic corruption within the health sector partly through an increase in citizen reporting. However, there was no concomitant increase in convictions for corrupt acts as a result of this improved detection. One reason for this lack of enforcement was the weak political support for this agency's activities, limiting its ability to investigate and prosecute the corrupt behavior it uncovered, particularly at higher levels of the government (65).

In contrast to the experience in Karnatka, an anti-corruption agency in Uganda was granted substantial enforcement authority and was formed by the president himself in response to pervasive health sector corruption (66). This agency was responsible for a significant decline in bribery among health care workers, the recovery of millions in USD worth of stolen health supplies, and the conviction of health care workers for corruption-related crimes. However, without a simultaneous effort to raise salaries and improve working conditions, health care worker morale deteriorated under the agencies aggressive tactics resulting in a prolonged strike that that debilitated the nation's health system (66).

These examples highlight the danger of applying a reductionist, rather than a systems-thinking approach. Forming an anti-corruption agency addresses a component of the system – individual acts of corruption among service providers. However, they do little to address the working conditions, institutional and economic factors, and social norms that enable individuals to ask for a bribe or divert medical supplies. At a minimum, the status quo remains in effect if there is no political backing of the agency or ability to enforce anti-corruption regulation, as highlighted by the example in Karnatka. At their worst, they can result in significant unintended consequences that further weaken the health system, as highlighted by the example in Uganda. Although allocating resources to enhance detection and enforcement has the potential to reduce individual corrupt actions in the short-term, these tactics may only represent a "quick fix." Over time, aggressive enforcement of corruption in isolation can decrease health care worker morale resulting in increased number of health care workers leaving the public sector. This would have the unintended and delayed consequence of further weakening the health system (Figure 3A).

Community engagement

Another strategy used to reduce corruption is mobilizing community members to hold actors in the health system accountable through enhanced transparency. For example, the presence of a monitoring board composed of community members in Bolivia was associated with a decrease in informal payments and overpricing for supplies and medications (67). A randomized control trial in Uganda demonstrated that health care service delivery and population health indicators improved when citizens were provided performance metrics on their health facilities and encouraged to engage with health care workers to develop a shared action plan to improve local health outcomes (68). Lastly, formalized citizen feedback can catalyze and inform anti-corruption efforts. Information from social audit surveys that polled perceptions of and experiences with

TABLE 2 Examples anti-corruption theories and corresponding strategies.

Anti-corruption theory	Example strategies
Strengthening accountability, detection, and enforcement	• Anti-corruption agencies • Improving technical infrastructure to detect irregularities • Legal framework for prosecution of health sector corruption
Increasing transparency	• Community monitoring boards • Anti-corruption media campaigns • Publicizing performance metrics for health care worker and facilities (i.e. report cards) • Publicizing resource allocation and spending in health • Disclosure of financial relationships
Prevention	• Increasing health care worker salaries • Allocated resources to the health sector to improve working conditions • Incentives for "clean behavior"

corruption in Nicaragua were used to lobby for anti-corruption policies and ethics training for public officials (69).

Similar to anti-corruption agencies, it is unclear if community engagement as an isolated strategy is sufficient to curb entrenched health sector corruption. For instance, a randomized trial evaluating the effectiveness of a community-based transparency campaign in Tanzania and Indonesia failed to improve health outcomes in the intervention communities (70). In this study, citizens were invited to attend meetings with a facilitator to discuss their experiences with and develop a set of activities to address maternal and newborn health in their community. However, there were no resources or support provided by the program outside of these facilitated meetings. At the conclusion of the study, there was no significant improvement in the use of perinatal and postnatal services, birth weight, or feelings of civic engagement between the intervention and control groups. The authors speculate that it was challenging for participants to operationalize the ideas developed during the facilitated discussions into actions that would lead to tangible improvements (70).

In fact, methods commonly used to engage community members through increased transparency could have the unintended consequence of leading to more corruption. At least two studies have shown that exposing citizens to anti-corruption media actually increased their willingness to pay a bribe (71, 72). The content of the media varied in each study, but included messaging on the pervasiveness of corruption (72), recent corruption scandals, the impact of corruption on communities, and recent anti-corruption efforts undertaken by the government (71). It is possible that anti-corruption media campaigns may perpetuate feelings futility and powerlessness among community members, rather than mobilizing them to combat corruption (71).

These examples address one component of the system – public awareness of corruption. The long-term goal of these awareness building campaigns is to hold those in position of power accountable. However, if enhanced transparency is not coupled with legitimate and visible efforts by health care workers to improve services or government to commit resources to improve the health system or deliver on anti-corruption policies, then advertising the extent of corruption may only perpetuate the perception that corruption is pervasive and inevitable (Figure 3B). This can create a reinforcing loop where citizens believe that corruption is ubiquitous and therefore they engage in corruption. The ultimate result is even more corruption that becomes increasingly institutionalized within the system.

Raising salaries

Lastly, investing resources in health systems of LMICs, specifically to improve wages of health care workers in the public sector, may itself represent an anti-corruption strategy. Despite increased spending on health care globally over the past 2 decades, there are significant disparities in per capita spending between in HICs ($5,252 USD) and LMICs ($40–81 USD) (73). This disparity in funding may underly the aforementioned pattern seen in LMICs of health care workers engaging in corruption to supplement unsustainably low public sector salaries. Consequently, it is plausible that health care workers may be less likely to engage in dual practice, solicit informal payments, and/or divert supplies and medications to supplement their income if they are paid an sufficient and reliable salary. Adequate investments in health sector infrastructure, equipment, and guarantee of supply chains for therapeutics and consumable supplies can improve access to services, which could also deter perpetuation of an unregulated private sector within health systems of LMICs (74).

Ecological studies incorporating data from numerous countries across multiple continents indicates that, specifically in LMICs, there is an association between higher civil servant salaries and lower corruption (75, 76). However, based on modeling from one of these studies, salaries would need to be increased substantially to eliminate corruption if raising wages was the only strategy used (i.e., in the absence of concomitant enforcement mechanisms to deter corruption) (76). Moreover, on an individual country level, the suggestion that higher salaries alone will reduce corruption is less clear. In 2010, the Ghanaian government doubled police officer salaries, in part to reduce corruption within the police force. However, efforts to solicit bribes and the monetary value of bribes paid to police officers actually increased after 2010, suggesting

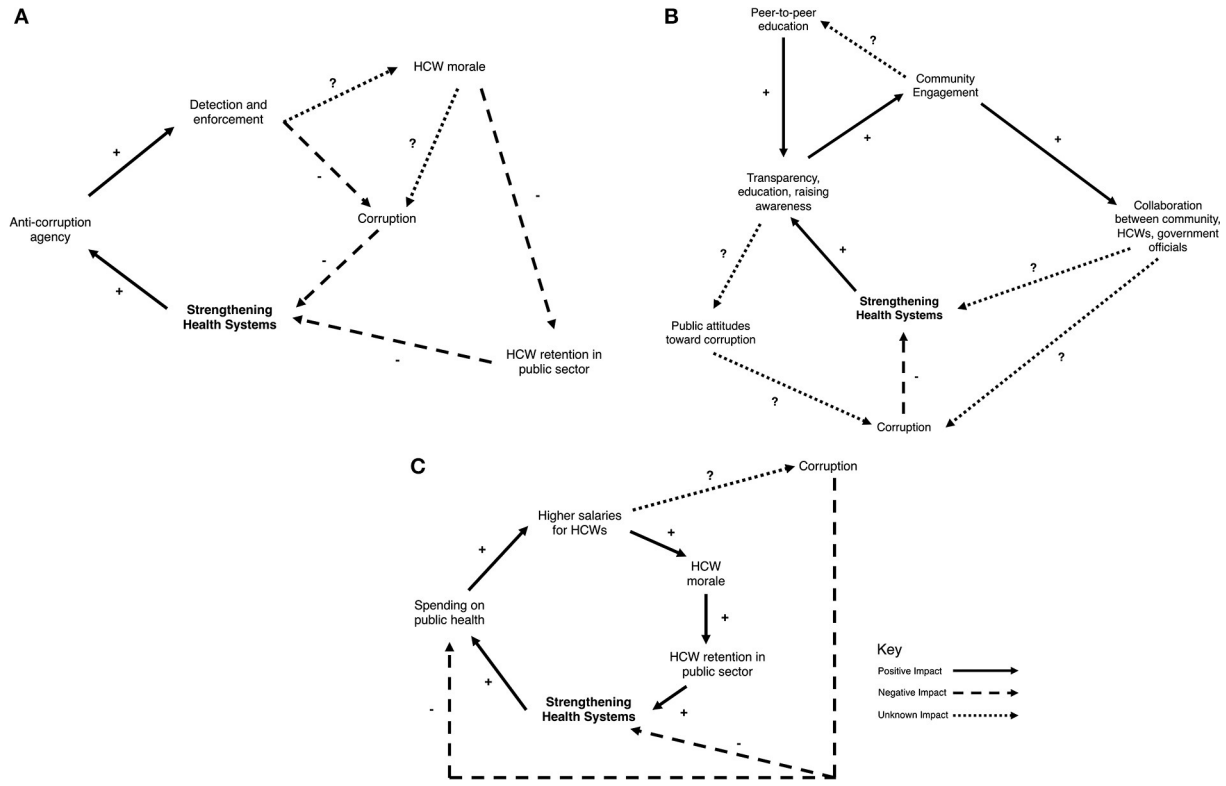

FIGURE 3
Causal loop diagrams for the following anti-corruption strategies. **(A)** Anti-corruption agency, **(B)** community engagement, and **(C)** raising salaries.

the higher salaries exacerbated corruption (77). The authors offered potential reasons for this unexpected result. First, raising salaries may have contributed to a sense of entitlement among police officer to expect higher bribes. Also, the higher income may have created additional pressures to financially support extended family members that necessitated the solicitation of more bribes (77).

Although not specific to the health sector, this example highlight the complicated nature of corruption. Supplementing low salaries may be one reason for engaging in corruption, but there are important social and institutional factors that also contributed to a police officer's willingness to solicit a bribe. These other factors may not be readily apparent without utilizing a systems-thinking approach. In this example, raising wages without interventions that address other aspects of the system, such as a concomitant effort to enhance detection and enforcement of corrupt activities or change the institutional culture away from bribe-taking, may actually act as reinforcing feedback that amplifies corruption. In the case of a health system, implementation of strategies targeted only one aspect of the system may not only by exacerbate corruption, but also by direct significant resources to a solution that is ultimately ineffective at achieving the intended goal (Figure 3C).

Discussion

Applying systems-thinking tools to address health sector corruption

As previously discussed, health systems are comprised of complex interactions between numerous actors. These systems are extremely heterogeneous in terms of structure, funding, incentives, resource allocation, etc. Furthermore, there are key differences in the socio-economic and political environments within LMICs and HICs that impact health systems within these countries, including the role of donors and development aid. Consequently, adapting an anti-corruption strategy that was developed in HICs to a health system in LMICs may do little to improve the system or result in unintended consequences that exacerbate corruption or further weaken the health system. These challenges of adaptation are highlighted by the aforementioned example of implementing an anti-corruption agency. For these reasons, corruption in the health sector, specifically within LMICs, is a problem in need of a systems-thinking approach.

Systems thinking has been previously applied to understand corruption in LMICs outside of the health

sector (78, 79). These previously employed strategies can be combined with a health system strengthening framework put forth by de Savigny et al. (80) to better understand and disrupt health sector corruption. We propose a 4-part process to apply systems thinking to health sector corruption: qualitative analysis, developing a system map, designing an intervention, and developing an evaluation framework.

Qualitative analysis

A qualitative analysis is an essential first step to a complete understanding of health sector corruption. Some have argued that corruption is particularly intractable because it serves a function in the system (78). Consequently, interventions that disrupt this function will be met with resistance. Based on studies cited above, the function of practices such as absenteeism, theft/diversion, and informal payments within the health sector of LMICs may include access to faster services or supplementing low salaries. However, given the heterogeneity of health systems globally, a local understanding is required to fully appreciate the role corruption plays in a given system.

A key component to this local understanding is getting input from actors at all levels of health sector, including those in positions of leadership (Figure 1). This qualitative input should focus on the informants' perceptions of, personal experiences with, and motivations underlying corruption in the health sector. Informants should also be asked about their impression of the health system more broadly, including their understanding of the incentives, configuration of leadership, regulations, renumeration structures, accountability structures, etc.

Analysis of this qualitative data can then be organized into themes that provide stakeholders with a better understanding of health sector corruption. As an example, qualitative analysis was performed by Scharbatke-Church et al. (81) to better understand corruption within the criminal justice system in Northern Uganda. Through this analysis, they identified several functions of corruption, including access to police or judges, maintaining power, or to generate revenue for operating costs to the maintain the system. Applying a similar strategy to the health sector has the potential to not only reveal to types of corruption that are occurring and the actors involved, but more importantly, its functions and the key dynamic relationships that enable corruption and maintain its role in the health system. Moreover, this deep understanding of the system will prevent inappropriate adaptation of anti-corruption programs that were utilized elsewhere.

System mapping

The understanding of the system gained from the qualitative analysis can then be used to develop a causal loop diagram. The goal of the causal loop diagram is to visually represent the complex relationships between variables within the system that contribute to corruption (81). This approach was used in in Pakistan where Ullah et al. (79) conducted a thorough qualitative analysis focusing on citizens' experience with, perceptions of, and strategies for combatting corruption. Based on the themes extracted from this analysis, they created a comprehensive causal loop diagram modeling corruption in Pakistan that was inclusive of social, economic, legal, and political relationships. Through this process the authors identified several variables contributing to corruption that were under recognized in literature, such as the role of inflation, religious values, the size of government, and transparency in development aid. In Northern Uganda, a system map of the criminal justice system was essential to identifying both the drivers and enablers of corruption and the function that corruption serves in the system. This information was critical because most of the existing anti-corruption strategies in this region were only addressing enablers, not drivers, of corruption (78).

In the setting of health sector corruption, variables contributing to corruption may include suboptimal work conditions; low salaries for public sector workers; long wait times for services; scarcity of medications and/or medical supplies; lack of monitoring and accountability of health care workers, industry, suppliers, donor agencies, and policy makers; knowledge asymmetry between actors; corrupt behavior modeled by those in leadership positions; etc. After all the variables have been identified, one can use causal links to illustrate the dynamic relationships between variables. This system map complete with variables and causal links can help stakeholders identify reinforcing loops that exacerbate corruption or stabilizing loops that promote an equilibrium of corrupt behavior that becomes institutionalized within the health system. A potential example of how corruption can become institutionalized is the experience of public health care workers in rural Uganda who negotiated changes to facility workflow in order to accommodate for baseline staffing shortages due to pervasive absenteeism (53).

Furthermore, an understanding of these dynamic relationships is critical to anticipate temporal delays between and downstream effects of a precipitating factor and the ultimate outcome. Combatting corruption in the health sector is a long-term endeavor, understanding where delayed results could occur will prevent stakeholders or funders from prematurely abandoning an effective strategy where evidence of success may not be readily apparent. This comprehensive representation of the system is essential to designing an effective intervention.

Designing (and refining) an intervention

After a health system and the impact of corruption on the system has been sufficiently mapped, an intervention can be developed. Using the format proposed by de Savigny et al. (80)designing an intervention starts with getting input from key stakeholders who represent different levels of the system and are positioned to understand areas that need to be improved. In the case of reducing health sector corruption in LMICs, these key stakeholders may include government officials and other policy-makers, donors, development organizations, payers, suppliers, providers, and patients. An ideal intervention should utilize a combination of measures that address different variables within the system (82). As highlighted by the anti-corruption strategies mentioned in previous sections, targeting one component of the system is unlikely to bring sustainable change. For instance, only addressing incentive structures by raising salaries without a concomitant effort to bolster monitoring and enforcement may perpetuate and even exacerbate corruption as seen in the example from Ghana (77).

Any potential intervention should then be applied to the system map to assess its effect on existing feedback loops, anticipate unintended consequences, and identify delayed outcomes. System dynamics modeling is one approach to this assessment. System dynamics modeling is an iterative process that utilizes mathematical modeling to predict the impact of various hypothetical scenarios on a given system (83). Information from these models can be used to further refine the intervention to mitigate negative downstream effects or unintended consequences.

Developing an evaluation framework

Once an intervention has been designed and refined based on the system map, then an evaluation framework can be developed. However, there are some important features of corruption that must be considered when creating an evaluation strategy. First, the illicit nature of corruption makes it challenging to identify indicators of progress that can be reliably measured (84). Moreover, there is no clearly defined "road map" for successfully mitigating corruption in the health sector (64) and therefore typical monitoring and evaluation approaches for public health programs may not apply in this setting. Lastly, it will be challenging to anticipate every potential impact an intervention may have on systems as dynamic and resistant to change as health sector corruption in LMICs. For these reasons, evaluating the progress of anti-corruption strategies requires a non-traditional approach.

An example of such an approach has been previously described for a collective action intervention to reduce corruption in the criminal justice system of the DRC (84). Although a thorough systems analysis was performed at the outset, the authors describe a frequent monitoring and evaluation process characterized by an openness to challenge this initial analysis and make changes based on feedback collected after implementation of the intervention. Importantly, this feedback came from program participants rather than implementers (84). This example demonstrates that an iterative evaluation framework based on feedback from patients, providers, suppliers, and policy-makers may be preferable to a rigid evaluation plan with pre-defined indicators for success for addressing health sector corruption. In addition, frequent evaluation in the context of the system map should be included to make any changes to the intervention if necessary.

Conclusion

Health care delivery results from an intricate series of interactions between numerous different actors within the system. It is clear that pervasive corruption is a detriment to effective health care delivery, particularly in LMICs. Addressing health sector corruption has the potential to strengthen health systems where they have historically been weak. However, due to the complexity and heterogeneity of health systems globally, a comprehensive understanding of the system structures that underly the individual instances and patterns of corrupt behavior is essential to developing an effective anti-corruption strategy. Anti-corruption strategies developed without this understanding are unlikely to result in meaningful improvements and may even further weaken health systems. Consequently, health sector corruption in LMICs is a problem in need of a system-thinking approach in order develop and successfully implement mitigation strategies that result in sustainable improvements in health systems and consequently, the health of populations.

Author contributions

EG performed the literature review, applied the systems-thinking conceptual framework to corruption, and wrote the article.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Lessons learnt of the COVID-19 contact tracing strategy in Islamabad Capital Territory, Pakistan using systems thinking processes

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The strategy of test, trace and isolate has been promoted and seen as a crucial tool in the fight against the COVID-19 pandemic. As simple as the slogan sounds, effectively implementing it turns into a complex endeavor with multiple moving parts and the need for multisector collaboration. In this study, we apply a systems thinking lens to analyse the design and implementation of the contact tracing strategy for COVID-19 in the district of Islamabad, Pakistan. The data collection included participatory observation, reflective exercises, key informant interviews and participatory workshops with district health managers and health providers. The information gathered was structured using process and stakeholder mapping to identify the lessons learned of the COVID-19 contact tracing strategy. The results showed that the elements crucial for implementation were, good coordination during a crisis, available resources mobilized effectively and establishment of early active surveillance for contact tracing. Furthermore, the main aspects to be improved were lack of preparedness and existing surveillance systems and task shifting leading to impact on regular health services. The results of this study highlight the importance of developing information systems that are coherent with existing processes and resources, even in times of crisis.

KEYWORDS

COVID-19, systems thinking, contact tracing, health system, district

Introduction

WHO has recommended since the onset of the COVID-19 pandemic that a robust test, trace and isolate strategy should be at the core of every country's response and is essential to mitigate the impact of COVID-19, globally. An effective contact tracing strategy should be able to isolate a COVID-19 positive person within 2–3 days of detecting the case and quarantine at least 80% of its contacts, so zero new cases are infected (1). However, efficient and timely contact tracing is a complex process and the simplicity of the 'test, trace, isolate' understates the multitude of time-dependent processes that must occur seamlessly for the strategy to work effectively (2). Countries have therefore struggled to establish contact tracing systems that respond to the changing needs of the pandemic (3).

Contact tracing is a dynamic system with multiple moving parts. For individuals that test positive, several steps need to occur, which involve different stakeholders from the health and non-health sector. The speed and direction at which individuals pass through the system is often influenced by other factors outside their control (3). Each step requires management, logistics and well-resourced public health infrastructure and workforce. Furthermore, successful SARS-CoV-2 contact tracing requires timeliness and community engagement to encourage participation and cooperation of the population (4). Minimizing testing delay has shown to have the largest impact on reducing onward transmissions (5). The need for rapid results in turn requires increasing testing capacity and seamless relay of information. Multiple information streams (e.g., from community, public and private health facilities, laboratories, and surveillance teams) necessitate intricate information management (3).

Social dimensions are important intervening factors for health systems and its components, which do not work in silos. Contact tracing systems are managed and run by the health authorities, but require other sectors to work adequately (6). These non-state and non-health actors, such as the non-governmental and philanthropic organizations, local administration and the private sector, can and should have a synergistic role to improve community engagement and mobilize resources. This collaborative approach to implementing contact tracing is an imperative because whilst embedded within the wider health system, the contact tracing activities are in itself a complex system (3).

This complex nature of contact tracing systems requires that researchers and policymakers apply a comprehensive lens to understand and intervene in the system (7). Systems thinking can support this endeavor by providing tools and approaches that see the contact tracing system as a whole, with interlinked components and feedback loops. Applying systems thinking tools, such as process maps, can help in developing a shared vision and understanding of health issues as these are visual tools that provide a snapshot of the processes and the connectedness of systems (8). Iterative dialogue among diverse stakeholders using systems thinking skills can translate into firm commitments for collaborative action (9). Contact tracing can benefit from the pivotal steps in systems thinking of problem analysis, focusing on leverage areas, system redesign, reducing impact of unintended consequences and continuous learning and improvements. As the pandemic continues to evolve, the use of various models of systems thinking will provide new opportunities to understand and continuously test and revise our understanding of the complex nature of health issues, including how to modify approaches to improve people's health (10).

In this study we use a combination of system thinking tools—process mapping, reflective practice and stakeholder mapping—to extract the lessons learned and identify leverage points that could make the contact tracing system more efficient and responsive to the changing needs of the pandemic.

Methods

This study was conducted as part the 'Systems Thinking for District Health Systems (ST-DHS)' project that aimed to enhance capacities of the district managers for systems thinking for better decision making and health services implementation.

We conducted a qualitative case study using systems thinking tools to undertake a deep dive of the COVID-19 contact tracing system in Islamabad. We worked closely for months with the district managers and discussed with them, on an ongoing basis, the findings of the study. This allowed the health managers to become active agents of change (11). Two district managers, both engaged in leadership roles in the DHMT, were involved and actively participated in every stage of this research study: identification of the research questions, study design, data collection, analysis and writing of the manuscript.

Study setting

Islamabad is the capital city of Pakistan and is federally administered as part of the Islamabad Capital Territory (ICT). It has a total population of 2.2 million with almost an equal division in urban and rural settings (12). Like the rest of the country, this district has public primary, secondary and tertiary components that are managed by the federal health ministry and private healthcare facilities.

As soon as the initial cases of COVID-19 were identified in the country (13), the Pakistani government responded by strengthening the coordination, case detection, disease surveillance, rapid patient mobilization and community sensitization. The National Command and Operations Center (NCOC) and Ministry of National Health Services, Regulation

and Coordination (MNHSRC) developed national COVID-19 policy guidelines (14).

A surveillance system was constructed from the ground up in ICT and an adaptive contact tracing system was developed. A test, trace and quarantine center was established and started its operation against COVID-19, in which different stakeholders worked together with the NCOC and MNHSRC (15). Strategies for surveillance and standard protocols were devised. Multiple subsections were set up to account for surveillance, follow up and quick management of critical patients. With limited time and resources, Islamabad developed a focused strategy of testing, tracing, risk communication and home isolation. The ICT District Health Management Team (DHMT) operated in liaison with other vital stakeholders that facilitated their work (16).

Islamabad was selected for inquiry because this district developed a model COVID-19 contact tracing system which is under direct supervision of the NCOC and the MNHSRC. Another reason for its selection is that the proximity of research team to the district health office facilitated engagement as the COVID-19 restrictions tightened.

Data collection and analysis

Data collection was accomplished using various methodologies to triangulate the information gathered and gain a holistic understanding of the contact tracing in ICT. A combination of participant observation, key informant interviews and participatory workshops were undertaken (Table 1). Data collection was conducted between August and November 2020 by a team of three researchers from Child Advocacy International (CAI), a non-profit think tank in Islamabad. They were facilitated by the two district health managers.

Participant observation and reflective exercises

We worked together with the district stakeholders during the study duration. Our researchers were embedded in routine activities of the district team, attended routine meetings and accompanied day to day observations. Continuous discussions and engagement of the research and district team allowed for sense-making (17). Furthermore, the district team supported by the research team, conducted reflective practice sessions during monthly routine meetings. Reflective practice sessions aimed to facilitate critical thinking on the routine practices of the district managers (18). These sessions were documented through the researcher's and meeting notes. This initiated an understanding of contact tracing system for mapping of its various processes. Simultaneously, themes on the successes and challenges of this system also emerged.

Key informant interviews

Key informant interviews were conducted to understand the strengths and challenges of the contact tracing system. Participants were purposively selected aiming to gain diverse perspectives and experiences. Recruitment was facilitated by the district health officer. There were 16 respondents that included 4 Lady Health Workers, 4 surveillance team members, 3 data managers, 2 district health managers and 3 national policy makers of which 10 were male and 6 females. The interviews were conducted in-person and telephonically by the three researchers from CAI, led by SR, a senior public health clinician. Semi-structured interview guides were used to conduct the interviews in English and the local language, Urdu.

Procedures for informed consent were carried out. The participants in the district office gave written consent, whereas verbal consent was taken from the lady health workers posted in the field. All interviews were audio recorded and each interview lasted between 30 and 40 mins. Handwritten notes were taken by one of the researchers during the interview. The data in these notes were preliminarily examined and shared with the rest of the team. The interviews were not transcribed, but deductive coding was applied to extract the key lessons directly from the recordings, using rapid thematic analysis (19). This analysis was guided by the themes captured from the findings of the reflective practice. These were corelated with the interview notes and field notes made during participant observation. The findings were triangulated within the researchers and with the DHMT members.

The data from the interviews and participant observations was used to develop a preliminary process map (further description provided below).

Participatory workshops

Participatory workshops were organized iteratively with members of the district health management team, including the field surveillance teams, data management team as well as the community health workers. By purposive sampling to triangulate the findings of the key informant interviews and observations. Three workshops were conducted between August and September 2020. Each workshop had a duration of ∼2 h and was conducted in the district health office. The CAI researchers facilitated these sessions.

Workshop 1: Stakeholder mapping

The first workshop consisted in the development of a stakeholder map. Led by the researchers, the development of the stakeholder map was finalized in two sessions, which involved eight members of the district health team.

Stakeholder mapping was used to visually layout on one map, all the stakeholders involved in the contact tracing system. The main benefit of a stakeholder map is to get a visual representation of all the people who can influence

TABLE 1 Systems approaches used and their outcomes.

Method	Purpose	Outcome
Participant Observation and Reflective Exercises	Understanding the hierarchy of the DHMT and their contact tracing activities	Operationalization of the COVID-19 contact tracing system processes Identification of themes to describe ICT's COVID-19 contact tracing experience
Key Informant Interviews	Getting a broad-based view of the stakeholders engaged in COVID-19 contact tracing	Identification of the various processes within the contact tracing system and the strengths and challenges during its development and implementation
Participatory workshop 1: *Stakeholder mapping*	Identification of the nature of the different stakeholders and their level of engagement	Development of a map outlining the stakeholders engaged in contact tracing
Participatory workshops 2 and 3: *Process mapping*	Gaining insight into how the contact tracing activities work, including issues, time lags, use of resources and changes to improve the process	Development of a detailed process map of the COVID-19 contact tracing system in ICT Lessons learned from the contact tracing activities and ways to improve efficiency of this system

the process and how they are connected (20). This mapping located the activities being conducted at the level of each stakeholder and points of cross over where activities traversed different stakeholders.

Workshop 2 and 3: Process mapping

The second and third workshops aimed to validate the contact tracing's process map. Based on the data collected during the participant observation, reflective practice and key informant interviews, a map had been developed by the study team with Bizagi software and were presented to members of the district health team (8).

Three district managers participated in these two workshops and were invited to review and discuss the end-to-end processes of the contact tracing system, as well as the bottlenecks and challenges behind the system performance. Furthermore, the researchers facilitated a discussion to extract the most important and contextually unique lessons from the information gathered in these process maps (21). This information was validated with the insights gathered during the key informant interview.

During the participatory workshops, a study team member was responsible to capture reactions and ideas of the participants in notes.

Ethical considerations

The ethical committee of Health Services Academy, Islamabad awarded ethical approval. After written consent from the district health office, the study was embedded within the routine activities of the district health management team, who were explained that this study would bring no harm to the study participants. Verbal consent was taken from the managers, who were made aware of the participant observation period prior to its commencement. The data from the observations and interviews was anonymised and kept confidential in a password-protected computer to which only the researchers had access.

Results

The contact tracing strategy for COVID-19 in Islamabad required a complex and integrated set of activities implemented by stakeholders from different sectors in a poorly resourced system.

Contact tracing stakeholder map

The key stakeholders identified during the participatory workshops included health and non-health actors. The Surveillance cell at the district health office played a central role in coordinating the whole contact tracing strategy. The district surveillance teams were connected to most stakeholders and served as an information broker in the network. Other relevant stakeholders included public and private laboratories and hospitals, community health workers, police and the administration, which were directly interacting with patients and sentinel labs. National Institute for Health (NIH) is the central testing facility which provides the COVID-19 data and the NCOC, WHO, and district health office are the decision making authorities, at various levels. These are also the stakeholders with the most influence on the contact tracing activities. Figure 1 and Table 2 show the full list of stakeholders identified in the system, their characteristics and the main role they played in the contact tracing strategy.

FIGURE 1
Stakeholders for the ICT COVID-19 contact tracing.
* Lady Health Workers, Lady Health Supervisors, Vaccinators, Communicable Disease teams (Dengue, Polio), Expanded Programme on Immunization (EPI) outreach teams, Nutrition Supervisors.

Contact tracing process for COVID-19 in Islamabad

The goal of the contact tracing strategy in Islamabad was to test, trace and treat. The district health system in Islamabad put in place a complex sequence of activities implemented by different stakeholders in less than 2 months to track, trace and isolate all suspected COVID-19 cases. The end-to-end process for contact tracing in Islamabad can be seen in Figure 2.

The use of the process map enabled the identification of three sequential milestones emerging: (1) identification of confirmed and suspected cases, (2) contact tracing and (3) case management. In order for the system to achieve the goal mentioned at the beginning of this section, the process for each suspected case should reach each of these milestones. Failures to do so led to reduced performance of the system to control the pandemic. The milestones are described in detail below and in Figure 2.

Identification of confirmed and suspected cases

The first steps in the contact tracing system involved the identification of suspected cases and of lab confirmation of suspected cases (shown in Green in Figure 2). Suspected cases could be detected through four different mechanisms in Islamabad: (1) active and passive surveillance in the community during outreach activities by the Lady Health Workers, (2) directly at a testing facility, (3) during airport screening by the rapid response team and (4) targeted active surveillance activities by the district surveillance team.

At the community level, the Lady Health Workers (LHWs) were responsible to identify a suspected or confirmed case during their outreach activities. LHWs are regular government employees working as health workers in the community. They usually belong to the same community they are posted to work in. Incase the LHWs found a suspected or confirmed case of COVID-19, they would inform the surveillance team of the DHMT to collect samples at their home. The members of the community could also directly seek testing at a health facility or a specialized laboratory. Cases could also be detected by the rapid response team at the airport. A COVID-19 desk was set up at the capital's airport that screened the arriving passengers. Suspected cases were transported by the rapid response teams from the airport to the designated health facilities for testing and if positive, they were asked to home quarantine. The fourth mechanism to detect COVID-19 cases was through

TABLE 2 Responsibilities of the stakeholders involved in the contact tracing system.

Institution	Responsibility	Level
National Command and Control Centre (NCOC)	Overall stewardship for the national COVID-19 response and coordination of provinces	National
World Health Organization (WHO)	Technical support for general response and contact tracing at the district level	National, District
Ministry of National Health Services, Regulation and Coordination (MNHSRC)	Development of national COVID-19 action plan and guidelines	National
National Institute of Health (NIH)	Central testing facility for ICT and compilation of national test results and dissemination of daily lists of positive cases	National, District
Surveillance Cell—District Health Office	Hub of the COVID-19 surveillance activities for coordination, implementation of field activities through field surveillance teams and the COVID-19 data management and analysis for daily (local) statistics	District
Community Health Workers (CHWs)	Health workers covering both the urban and rural parts of the district who are responsible to perform risk communication activities, identifying suspected COVID-19 cases and liaising with the DHMT	District
Public and Private Laboratories	Testing facilities for COVID-19 and clinical management of patients that test positive	District
Non-profit organizations	Logistic support where NCOC needed it	National, District
Police and Security Department	Provison of security to the health field team	National, District
Education Department	Provided information on the students that tested positive for COVID-19 to the Surveillance cell prior to reception of the daily line-list	District, National
District Administration	Implementation of local restrictions and exemptions such as localized lockdowns	District

targeted active surveillance conducted by the DHMT. This active surveillance activity involved collecting samples from areas of congregation such as marketplaces, schools or mosques around the identified clusters of cases.

The data of all tested individuals was then shared with the National Institute of Health (NIH). The NIH received the information of all tested and created a daily list with a unique identification number for each suspected case. With the result of the test, the NIH would create a separate daily list of positive cases that would be shared with the district surveillance team.

Contact tracing activities

Once notified of confirmed cases, the surveillance team conducted face-to-face contact tracing activities (in blue in Figure 2). At their arrival to the houses of positive COVID-19 patients or their contacts, the surveillance teams got samples from all the available contacts and the members not present were instructed to seek testing at the district office or NIH. The samples from these activities along with the individual's details were deposited with the NIH, at the end of the day. A parallel inventory of these was also maintained in the district health office.

A contact was defined as anyone who had been in proximity (direct physical contact or having shared an enclosed space) with a lab confirmed case. Contacts could include health care providers, family members, friends, or work colleagues. Risk communication was also carried out during these visits.

The surveillance team listed all the information about the (provided) contacts on a Microsoft Excel list with their telephone numbers and addresses for follow up. Each contact listed was informed about the exposure status and the need for COVID-19 testing. All contacts were advised to quarantine whilst waiting for their test results. If the test results were positive, isolation was required either at home or in the hospital depending upon the severity of symptoms. The aim was to reach all contacts of a positive COVID-19 case within 24 h of the identification of the case.

Furthermore, the surveillance team analyzed the distribution of cases and identified geographically congruent areas of cases to plan active surveillance activities (such as mass testing).

Case management

At the beginning of the pandemic, the suspected cases were quarantined in designated centers at new hospital facilities, and other public sector places from the point of entry in the country and the community. But it was soon realized that it was not practical to keep people in these centers as the cases were growing and the capacity was limited. This prompted the early transition to home quarantine and isolation.

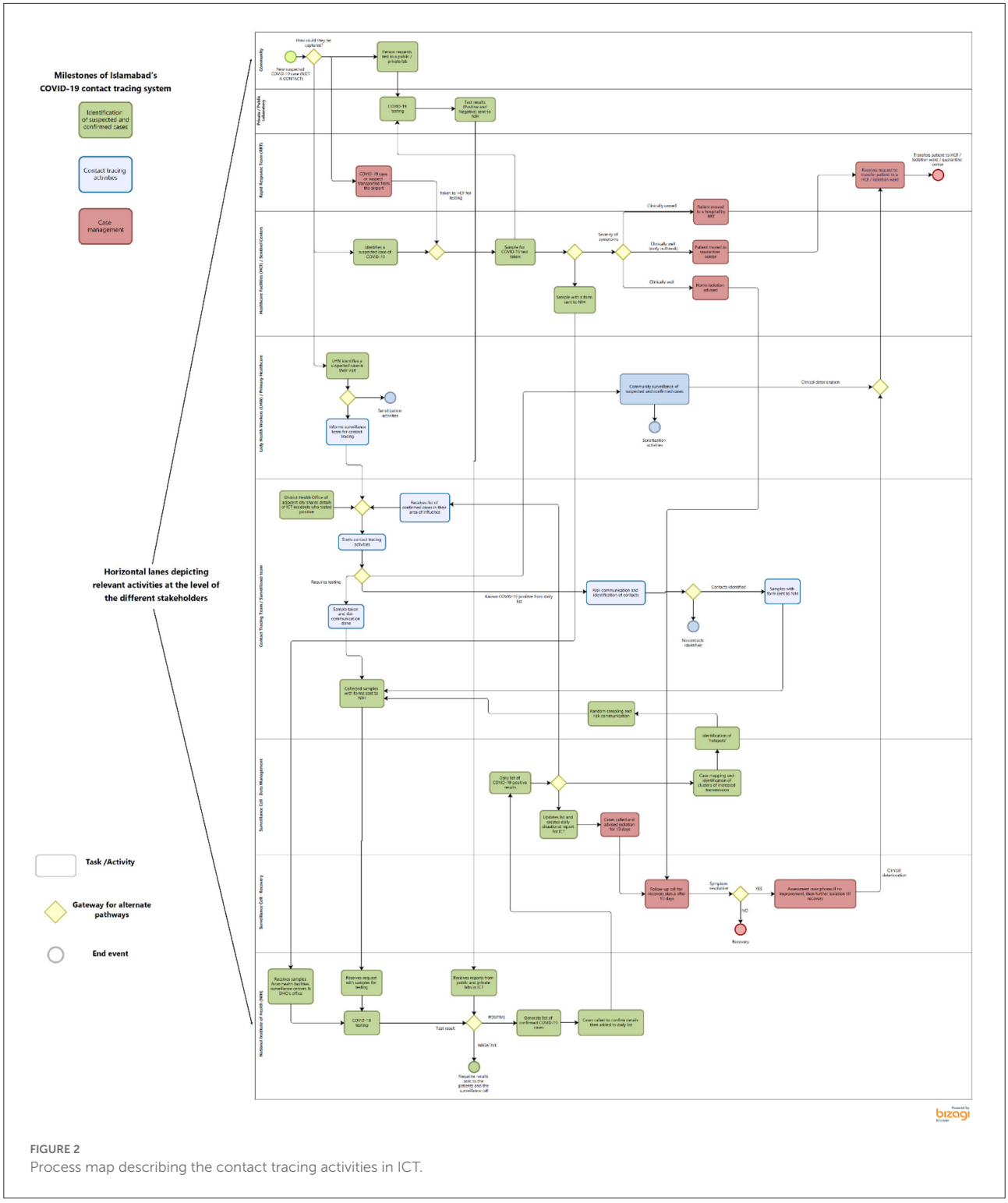

FIGURE 2
Process map describing the contact tracing activities in ICT.

All positive cases were followed up by telephonic calls during the duration of the isolation to inquire about their health and quarantine status (activities shown in red in Figure 2). Within the community, the LHWs made routine visits to the homes of the positive cases to follow-up and inform them about what worsening symptoms could look like. In the event of aggravation, patients were advised to either inform the LHWs or go to the nearest public health center. Cases that became unwell

and were unable to reach the facilities themselves, were moved to the designated health centers for management by the rapid response teams from the district health office.

Lessons learned of the COVID-19 contact tracing strategy in Islamabad

The collective analysis of the interviews, process map and the reflective practice exercises yield the main findings on the strengths and weaknesses of the contact tracing system compiled in this section. Islamabad's health system was unprepared at the arrival of the pandemic and the district health system's resources were already scarce in times of stability. The district management team, however, reacted quickly and reorganized the scarce resources around the COVID-19 response. The task shifting involved that other essential programs, such as maternal health services, were considered not a priority. The district's quick response also included the mobilization of additional resources, which was facilitated by the proximity of the district to the national stakeholders. Lastly, the experience of Islamabad shows the importance of the combination of passive and active surveillance in contact tracing activities to control the pandemic.

Lack of preparedness led to task shifting in the district health system

One of the key limitations of the contact tracing system was the fact that the health system was not prepared to absorb the impact of COVID-19. Before the pandemic, the district health system had scarce resources, including personnel, equipment and infrastructure to cope with the routine activities. With the rise in the number of COVID-19 cases requiring medical attention and the addition of new activities such as the contact tracing strategy, the system struggled to provide an appropriate response in the early stages of the pandemic. Community health workers who are supposed to provide maternal health services were tasked to report COVID-19 cases which put an extra burden on them.

> "*We have many tasks, including polio, but because of COVID we were only doing COVID work. Reporting COVID cases and telling them to test" (Lady Health Worker)*

Furthermore, Islamabad did not have a comprehensive infectious disease surveillance system in place. However, the district did have a polio contact tracing system which was utilized for COVID-19 contact tracing.

> *"When the pandemic started, there was no population surveillance system for infectious diseases in ICT other than that for polio. The ICT health system had scarce resources including human resources, finances and testing facilities even for essential health services and was ill-prepared to handle a pandemic of this scale with an extra burden of generalized testing, contact tracing and critical care infrastructure. To cater this, a test, trace and quarantine center was established in ICT by the end of February 2021."* (ICT DHMT member)

Task shifting to ensure a coordinated COVID-19 contact tracing strategy

Despite the scarcity of the health system resources, the response at the national and district level prompted a rapid establishment of the contact tracing strategy. Surveillance hubs were implemented as hubs of coordination and information of the COVID-19 response at the national, as well as district level. The national hub facilitated the day-to-day activities that were conducted at the District Surveillance Office.

> "*Even with the little human resource that we had, our DHO managed to kick start the contact tracing by utilizing everyone, delegating responsibilities and using available resources."* (DHMT member)

The DHMT initiated task-shifting activities and reorganized staff according to the emerging needs of the pandemic. Short capacity building sessions were held by the District Health Office to train personnel working in vertical programs such as LHWs and Dengue outreach workers to support with COVID-19 contact tracing activities. The trainings were conducted across teams and positions so that all team members became equipped to assist with the tasks in the surveillance hub. A critical example of the task shifting was the additional role the LHWs took on to notify suspected cases in the community.

> "*Since they (LHWs) already covered remote locations and scope was like their previous assignments, this proved quite useful for contact tracing".* (Member of DHMT)

The district did not only reallocate the existing resources, but it was also able to mobilize additional resources in short time. The proximity of Islamabad's district team to the national hub and the leadership of the district health team facilitated the receipt of additional resources.

> *"There was a shortage of vehicles; initially there were only 6 ambulances in the district office for Surveillance and Rapid Response Teams. Ambulances from the primary health care facilities were allocated to the district office for surveillance purposes as the primary health centers were closed initially. ICT management through its resources hired private vehicles*

> *for the teams. Some vehicles were also provided by a private bank for surveillance activities that helped solve the problem of logistics to a great extent."* (Member of DHMT)

Effective use of information at the heart of the contact tracing strategy

COVID-19 data was an essential and crucial success factor for the COVID-19 response. An information management team was created in the district office to manage local COVID-19 patient data. This allowed for a more streamlined close-looped data flow. Technical personnel were tasked to develop and run a local system of data management. These members collected, cleaned and maintained COVID-19 patient information on a regular basis that guided the activities such as contact tracing and random sampling. These data were also used for the generation of statistics for presentation at the Federal level. This system was perceived as efficient to promote data consumption across the national and district level and to produce timely and reliable data to guide decision making at the level of the district.

> *"Regularly collecting and analyzing data from the districts was a major success of NCOC"* (representative MNHSRC)

The district improved the data management system to provide data on COVID-19 cases and their contacts to the district health office. A line-list with the names, addresses and contact numbers of COVID-19 cases was developed by the NIH and sent on a daily basis to the district health office. This list combined information from public and private facilities, as well as from the active surveillance activities. The district surveillance team would review the list, reach out to contacts of positive cases telephonically and use the data collected to guide the DHMT's daily contact tracing activities (e.g., if an increase in cases was detected in a certain area of the district, random testing would be organized).

> *"The line-list includes all the diagnosed people from private labs, private hospitals, government labs, government hospitals and also samples taken by the district health office for contact tracing or random sampling. Every morning we distribute cases to the surveillance teams who go out in the city and trace the contacts" (member of DHMT)*

The contact tracing strategy combined passive and active surveillance to achieve a high and efficient coverage

Rather than relying only on regular reporting of COVID-19 cases from the health centers and community, the district surveillance team went out in the field to actively look for the cases in the community using available resources, such as the LHWs or polio outreach activities. The combination of active and passive surveillance activities was perceived as a useful and effective tool. However, as the system was relying on manual activities, it reached a saturation point as the cases raised in following COVID-19 waves. The human resources struggled to conduct all the activities in the defined timelines. This led to more task shifting in the activities of the contact tracing system, as well as delays and inefficiencies.

> *"Passive surveillance alone would not have worked as not many patients report to the health system and only active surveillance system available was of polio, which was utilized to actively trace people with COVID."* (Representative MNHSRC)

Discussion

Rapid spread of COVID-19 outbreak challenged health systems to design appropriate control interventions. A well-functioning contact tracing system is a key intervention to interrupt transmission and directly reduce COVID-19 mortality (22). In our study, we found that early partnerships, continued coordination, task shifting and decentralization helped make Islamabad's contact tracing effective. However, as the number of cases increased, the efficiency of this system was challenged. We also propose that systems thinking is not only a research tool but should be embedded in any ongoing and future management and implementation activities in epidemic preparedness and response.

The onset of COVID-19 brought health systems to the edge of their capacity, magnifying existing challenges and exposing some of their design flaws. Pakistan's health system with a chronically underfunded primary health care, limited availability of human resources and slow bureaucratic government processes was not up to a good start in December 2020 when the first cases of COVID-19 were identified. Despite this, a coordinated and multisectoral whole of government response at the early stage of the pandemic (15) allowed some of the districts to creatively redesign their health systems (16).

At the core of the test, trace and quarantine strategy in Islamabad were active and passive surveillance efforts. ICT's authorities leveraged the existent active and passive surveillance system used in the fight against polio, to integrate the surveillance activities for suspected COVID-19 cases. Adopting the polio surveillance system for COVID-19 shows the importance of building on existing information systems even when these are inadequate. By using the existing resources, the district health authorities managed to mobilize and set up quickly a system that could leverage on existing resources (technological, human and operational). Previous emergencies and crisis have shown that building parallel information systems

that seem crucial in the short run has long-term sustainability implications, as was the case of the Ebola death notification system, which collapsed after Ebola finished (23, 24). The example from Islamabad shows that it is possible to build on existing systems even during times of crisis. The lessons learned during the last 2 years should not be limited to COVID-19 or polio, but rather serve as the basis to build a comprehensive surveillance system that will support the district and country in the preparedness and response to future public health challenges.

The active surveillance activities tiered the local COVID-19 response in a way that kept the burden off the tertiary health centers in the city (25). Additionally, the active contact tracing activities did not only enable data collection and analysis but also created an opportunity for risk communication to the community. A previous study on tuberculosis contact tracing compared active and passive contact tracing in Nigeria and concluded that the health outcomes of the individuals that were actively traced were significantly better compared to the passively traced. The authors concluded that this difference was due to the health education imparted by the contact tracers during active surveillance (26).

In order to overcome challenges that active surveillance poses due to its labor intensity, contact tracing through mobile apps and location tracers is currently being used by many countries (27). Despite the wide use of digital contact tracing tools in high-income countries, there are ethical and security concerns, as well as uncertainty about their cost-effectiveness (28–30). For this reason, the majority of health departments in low-and middle-income countries, including Islamabad, use a manual process to track COVID-19 cases and contacts but this becomes time consuming, inefficient, error prone and difficult to scale. These shortcomings extended into data management that was also being done manually and by a limited staff. The delays in case identification and isolation during high COVID-19 caseloads in ICT may have been avoided in the presence of automation.

A coordinated response is crucial for any contact tracing system, as many stakeholders and information are involved. When the system is manual, a coordinated response becomes even more relevant, as it should reduce duplication of efforts. In Pakistan, the coordination tasks became the responsibility of the NCOC, a newly developed body which oversees activities inside and outside the health sector (13). The district also established a coordination hub—the surveillance cell—for the COVID-19 response, this allowed, as described in the findings, the orchestrated response within and outside the health sector, but also the mobilization of additional resources. The Islamabad model adapted itself through the reallocation of the human and infrastructural resources to the unfolding adversity. While the most basic health facilities had to be closed as a part of preventive measures, the support of the LHWs to the surveillance activities within the community, expedited the identification and, therefore management of the COVID-19 cases. Although no formal policy existed, informally there was an early partnering with non-health actors to support logistical amenities such as vehicles for transport.

In the district of Islamabad, a certain level of autonomy provided by the decentralized health system accelerated the implementation of Islamabad's individualized response strategy of test, trace and quarantine, as well as localized lockdown, in certain instances of sub-sectors. This could not have been as systematic, and prompt if the pandemic control had been entirely central. Studies on contact tracing from Rwanda and Uganda, have identified decentralization as an important factor for a comprehensive response (1). In contrast, an Italian study has argued that an effective national preparation and coordination is crucial in a decentralized system, where the strengths and weaknesses of local organizational capacities of the districts are exaggerated in times of crisis. This was the case of Italy, where decentralization mattered both in a negative (as in Lombardy), as well as in a positive way (as in Veneto and in Emilia-Romagna) (31). Lastly, the example of Indonesia shows that a coherent response strategy from district and municipal governments helped drive coordinated contract tracing regimes and set up their own social support services (32). These examples probably highlight the need to develop context-specific strategies. In the case of Pakistan, the existence of a coordination mechanism between the national and district level and some degree of autonomy at the district level probably enabled the success of these strategies. Furthermore, public private partnerships were particularly important to enhance testing.

Many elements and stakeholders coexist in the contact tracing system, that are interlinked and dependent on each other. With the application of systems thinking research tools, we were able to identify leverage points in ICT's contact tracing system and trigger reflective discussions among district team members on how to improve the processes. The use of visual tools such as the process map and stakeholder map allowed the generation of lucidity of the processes and interlinkages within systems, directing attention to appropriate allocation of the limited resources. As the outbreak progressed, certain activities went on unnoticed. The discussions among district health members and other sectors identified these hidden processes, such as early referral of a suspected case to the district office from the community by the LHWs. This provided an opportunity to revisit their design for optimisation.

Recent literature questions the validity of existing disaster management systems, which tend to use linear approaches and proposes an integrated critical systems approach for pandemics (33, 34). Our study echoes the usefulness and functionality of systems thinking approach in the complex processes involved in pandemic control and highlights the potential of these approaches in operational activities This may be especially important for settings with limited resources, such as Islamabad, where timely adjustments and adaptations will reduce the strain on the health system.

Conclusion

This case study exhibits the successful contact tracing design from a health system that was theoretically unprepared for an infectious disease outbreak of this proportion. Its hallmark is the early partnership between the Islamabad's district health office and other local health providers, as well as non-health actors. The comprehensive understanding of the district was necessary for the contact tracing strategy combined with dedicated structures to manage the coordination were crucial for the success of the strategy. Furthermore, the adaptive planning that included resource shifting and mobilization from other health facilities in the Federal capital, enabled the sustainability of these services.

The experience collected in this study should be used to prompt legislation for the development of a more robust basic health infrastructure to cater for prospective such events and health system strengthening should be a priority. Increasing resource allocation to health to strengthen health systems may lessen the diversion of resources, which had to be done as the number of cases steeply rose. Lastly, our study highlights the potential role that systems thinking approaches can have to enhance health system effectiveness in times of pandemic and beyond for implementers and policy makers.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

The authors confirm contribution to the paper as follows: study conception, design and draft manuscript preparation: SZ, CF, MB, DC, SI, ZZ, and FK. Data collection: SZ, MB, SI, FK, and ZZ. Analysis and interpretation of results: SZ, MB, SI, CF, DC, ZZ, and FK. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Using and improving the PHISICC paper-based tools in the health facility laboratories: Examples of Human Centered Design taking systems thinking into practice, in Côte d'Ivoire and Nigeria

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Background: Health workers in low- and middle-income countries are increasingly demanded to collect more and more data to report them to higher levels of the health information system (HIS), in detriment of useful data for clinical and public health decision-making, potentially compromising the quality of their health care provison. In order to support health workers' decision-making, we engaged with partners in Côte d'Ivoire, Mozambique and Nigeria in a research project to conceive, design, produce, implement and test paper-based health information tools: the PHISICC tools. Our aim was to understand the use of PHISICC tools by health workers and to improve them based on their feedback.

Methods: The design Health Facility Laboratories (HF Labs) in Côte d'Ivoire and in Nigeria were set up after months of use of PHISICC tools. Activities were structured in three phases or 'sprints' of co-creative research. We used a transdisciplinary approach, including anthropology and Human Centered Design (HCD), observations, shadowing, structured interviews and co-creation.

Results: Health workers appreciated the standardization of the tools across different health care areas, with a common visual language that optimized use. Several design issues were raised, in terms of formats and contents. They strongly appreciated how the PHISICC registers guided their clinical decision-making and how it facilitated tallying and counting for monthly reporting. However, adherence to new procedures was not universal. The co-creation sessions resulted in modifications to the PHISICC tools of out-patient care and postnatal care.

Discussion: Although health systems and systemic thinking allowed the teams to embrace complexity, it was the HCD approach that actually produced a shift in researchers' mind-set: from HIS as data management tools to HIS as quality of care instruments. HCD allowed navigating the complexity of health systems interventions due to its capacity to operate change: it not only allowed us to understand how the PHISICC tools were used but also how to further improve them. In the absence of (or even with) an analytical health systems framework, HCD approaches can work in real-life situations for the ideation, testing and implementation of interventions to improve health systems and health status outcomes.

KEYWORDS

health information system (HIS), quality of care, equity, Nigeria, Côte d'Ivoire, Human Centered Design, health workers, decision-making

Background

Frontline health workers in low- and middle-income countries (LMIC) are increasingly asked by governments and donors to collect more and more data on their activities and to report them to higher levels of the system, compromising their dedication to health care service delivery and overloading them with routine health information systems (HIS) demands (1, 2). More recently, digital tools have come into play and been promoted by international organizations (3). While the potential gains brought by digital systems are enormous, they can also worsen this situation as they can easily cause data proliferation and redundancy (4). Furthermore, in many areas the infrastructure and services to support digital tools are infeasible at present and, in some cases, in the foreseeable future supporting the approach of hybrid systems (5). In order to support frontline health workers' decision-making, addressing these issues, we engaged with partners in Côte d'Ivoire, Mozambique and Nigeria in a research project to conceive, design, produce, implement and test innovative paper-based information tools: the "Paper-based Health Information Systems in Comprehensive Care" (PHISICC) research programme (from 2016 to 2021) (6).

PHISICC was conducted by a transdisciplinary team with team members from a range of disciplines including from public health and social sciences, to ministry decision-makers, frontline health workers, design researchers and graphic and interaction designers. The project synthesized the global evidence on health information systems; characterized the HIS in the three countries, focusing on opportunities for intervention in the HIS; and redesigned, using a co-creative Human Centered Design (HCD) approach, a suite of health information tools. The PHISICC tools covered most Primary Health Care services areas (i.e. antenatal care, deliveries, postnatal care, vaccinations, sick child, outpatients, tuberculosis, HIV and referral) and included the patient registers, tallies and the monthly reports. The tools were tested for their effectiveness on data quality and use and health outcomes, as well as health worker satisfaction in a cluster randomized controlled trial (RCT) in each of the three countries.

"Systems thinking is an approach to problem-solving that views problems as part of a wider dynamic system. It recognizes and prioritizes the understanding of linkages, relationships, interactions and interdependencies among the components of a system that give rise to the system's observed behavior" (7). While the practice of systems thinking is often focused on the comprehensive and insightful *mapping* of systems, the implicit or explicit goal of that mapping is to identify opportunities for *intervention* into that system (8). The question is, though, how to design interventions which effect change in health system performance and, eventually, in population health outcomes (9).

PHISICC followed the established HCD practice of engaging health workers early in the intervention design process as partners in the intervention's design rather than as passive informants whose role is to provide feedback on concepts

developed by separate, "expert" designers (10). Holeman and Kane have described HCD as "frequently involving:

- meaningful and documented participation of people who will use new systems in their routine activities or otherwise be affected by them;
- supporting cooperative activity and augmenting people's skills, rather than using technology primarily for purposes of efficiency or managerial control; and
- concern for the whole person and their life experiences, reframing purely technical issues in relation to people's values and the broader human context of implementation" (11).

While evidence of the health outcome benefits of HCD are still emergent (12), this approach is increasingly being used in the field of public health. A growing body of evidence suggests that HCD affords significant opportunity to improve health outcomes (13) as it can "help the health community shift from prescribing solutions according to a *perception* of people's needs, to identifying solutions that actually meet their needs" (13). HCD brings a vitally important *tangibility and specificity* to the process of intervention design within the broader practice of systems thinking which, by its inherent comprehensiveness, tends toward *abstraction and generality*. If systems thinking helps us to "see the forest for the trees," HCD helps us "see the trees for the forest".

For the purposes of this report, we define HCD as follows: a research, design and problem-solving process in which knowledge about the topic of study is generated in dialogue with people directly involved in the topic and in which solutions to the identified challenges are created with the direct collaboration of those people most likely to benefit from them.

Concurrent with the PHISICC RCT, the PHISICC team continued to track the use, and improve the performance of the PHISICC intervention in a separate set of facilities, that we called the "Health Facility Laboratories" (HF Labs). The aims of the HF Labs were to deepen our understanding of the functionality of PHISICC tools, as well as to continue to improve the PHISICC tools in collaboration with health workers. We discuss the implications of HCD as a methodology in health systems thinking. This paper reports on the approaches, rationale and lessons learned from the HF Labs. Qualitative findings related to the trials outcomes are being reported together with the trials' quantitative findings in a forthcoming publication.

Methods

The HF Labs were conducted at selected three health facilities in Côte d'Ivoire and five in Nigeria. These facilities were not included in the data collected for the RCT. All health facilities were drawn from the same study sites where the trial took place, but from those that were not selected as intervention or control health facilities for the trials. Although Mozambique was also a study site for PHISICC, the team there did carry out the RCT but without the HF Labs component, due to logistical constraints. The methods of the RCT trials are fully reported elsewhere (14).

The Health Facility Labs included three phases of co-creative research and design (Figure 1):

1. A phase where the PHISICC tools were piloted in Nigeria (we called it mini-beta) from June 2019 up to July 2019, preceding the start of the RCT, in which dialogues with health workers and observations of the tools' in-context use provided the insights to make final improvements to the tools before they were deployed in the trials;
2. At the very end of the RCT, we conducted a "Research Sprint" and assessed the perceptions and experiences of the health workers in the eight HF Labs facilities (three in Côte d'Ivoire and five in Nigeria) regarding the PHISICC tools;
3. And a series of "Co-design Sprints" in which health workers, researchers and designers discussed additional incremental improvements to the tools based on the health workers' experiences with them.

Selected health facilities were of primary health care level, in rural settings and often remote. They were: Abbe Begnini, Achiekoi, Elevi in Côte d'Ivoire (health district of Agboville) and Abachor, Echumoga, Imaje, Okuku and Woleche Agi in Nigeria, Cross River State (Yala Local Government Authority). The HF Labs sites followed the same programme as those sites enrolled in the trials; namely, training on the new tools and use of the new tools with patients for over a year, replacing the usual, regular HIS tools. After 12 months of using the tools in Côte d'Ivoire and 18 months in Nigeria, the HF Labs design and research team re-engaged with the health workers at these eight facilities to discuss their experiences with using the tools. The HF Labs took place between February 2021 and June 2021 in both countries. The research sessions ("Research Sprint") and series of co-design sessions ("Co-design Sprints") were purposively organized sequentially between the countries to allow integration of cross findings from the different county visits and to further integrate new findings from the last rounds of visits into any follow-up visit.

The interdisciplinary team working with health workers in the HF Labs included public health researchers and academics in Nigeria and Côte d'Ivoire as well as designers and researchers involved in the initial fieldwork that characterized opportunities for intervention and the visual design of the tools themselves. Cross-country collaboration had to be restricted to video conferencing due to the challenges with international travel resulting from COVID-19 pandemic restrictions.

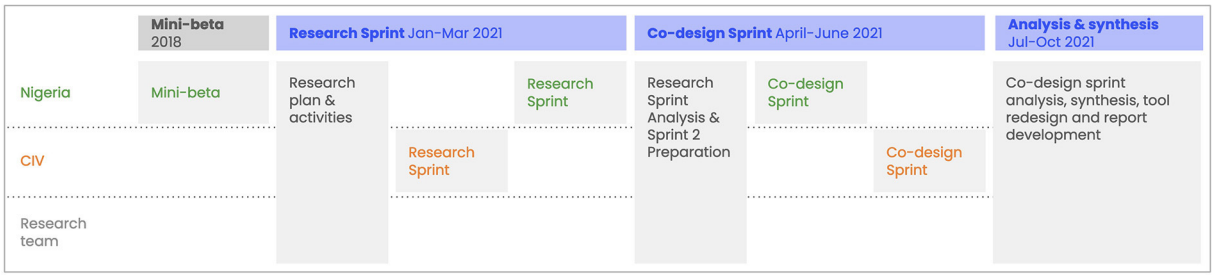

FIGURE 1
Health facility labs, overall approach and timeline.

Mini-beta pilot

The "mini-beta" was a rapid but instructive testing of the tools in five health facilities in Nigeria, where health workers were trained and used the tool for 6 weeks. The goal was to make any final design improvements and to ensure that no obvious errors could have unintended consequences in the use of the tools. At the end, the interdisciplinary team worked with health workers who had used the tools on a daily basis to organize the feedback and implement a set of final improvements to the tools prior to the start of the RCTs. Notes were taken in a field diary during interviews and observations of consultations, tallying and reporting.

Assessing the experiences of health workers

The research phase followed 12–18 months of use of the tools. After the trial period, health workers who had used the tools for an extended period of time became more informed about the tools' use than the designer team. Multidisciplinary research teams visited the health facilities, observed health care processes and management and collected data *in-situ* through notes and conversations with health workers. The repeated visits to observe the everyday workings of the rural health facilities (5 h in 5 days per health facility, approximately) created a productive rapport between health workers and the interdisciplinary team. A combination of observations (i.e., "shadowing"), conversations and structured interviews following interview guides were used to discuss the tools with health workers. A range of different types of health care areas (e.g., antenatal care and vaccinations) and administrative work, tallying, counting and preparing the monthly reports for the district were observed and discussed.

In Nigeria, on the first 2 days, the team divided into two groups and spent an average of 5 h in each health facility. During each of the visit, the health workers were shadowed as they carried out their day-to-day activities, conversations were also held on their use of the different tools and the challenges they had experienced, as well as in-depth interviews on the different aspects of the tools. On subsequent visits, a field editor was assigned to a health facility and the whole day was spent in the facility.

In Côte d'Ivoire, a total of three health facilities were visited by a team of five, consisting of two researchers, one representative of the Ministry of Health and two monitoring agents from the district. The research team spent an average of 5 h in each of the three health facilities during ten non-consecutive days.

Following the fieldwork, the team of researchers, both in and outside of the countries, developed research themes and findings and discussed possible redesigns or modifications to the tools based on health workers' feedback.

Co-design: Modifying and improving tools following their use

Following the research phase, co-design sessions with health workers were conducted in each country. The objectives of the co-design sessions were:

1. To respond to requests for improvements from the health workers participating in the HF labs and using the PHISICC tools.
2. To collect direct feedback and input on these proposed additions to the suite of PHISICC tools.
3. To engage in a creative dialogue with health workers about the merits and areas of improvements for the PHISICC tools.
4. To catalog additional ideas and critiques from health workers based on their experience using the PHISICC tools.

In Nigeria, the team conducted two separate co-design sessions, for which six health workers from the previous research phase were recruited. The sessions lasted 5 h on average. In the first session, the team had a group discussion using an interview guide. In the second session, the team worked in three groups creating the sketched copy of the outpatient (OPD) register and tallies, and thereafter the research team met to merge and synthesize findings.

In Côte d'Ivoire the research team organized two co-creation sessions. The first session lasted 5 h and was conducted with all four members of the three health facilities that were involved in the HF Labs, and the second co-creation session lasted 3 h and was attended by four healthcare workers from four health facilities who had been part of the trial.

Each co-creation session followed the following pattern: all the PHISICC tools (i.e., the eight health care areas covered by PHISICC) were considered for possible improvements. This led to a focus on two health care areas: OPD and postnatal care (PNC) registers. Different features of each register were offered as separate pieces of paper. Each of the participating health workers created their own proposed design and explained the reasons to the group in a round of "presentations." In this way, all health workers were able to ask questions and comment on the proposition and discuss problematic issues.

Consequently, during the analysis and synthesis phase (Figure 1), observations and findings were collaboratively organized into recurrent themes. Each different PHISICC tool and register was discussed from the perspective of health workers comments and in-situ observations of researchers. These paired critiques and observations revealed patterns and initial findings. The teams in Nigeria and Côte d'Ivoire compared findings and discussed implications for further improvements to the tools. Open questions and topics for further investigation were identified and explored through dialogue with health workers during the second round of site visits.

This process of pattern identification is consistent with the practice of human-centered and co-design. It follows the practice of combining different domains of knowledge to co-create new tools and approaches which embody different perspectives (15).

Studying the incorporation of PHISICC tools at district level

Rural, typically small health facilities have no designated administrative staff as such. However, administrative personnel of the health system at the state level and district level were involved during the training of health care workers for the mini-beta and their inputs were considered. Additionally, in Côte d'Ivoire, five members of staff at the district were interviewed about their experiences with entering monthly reports from the PHISICC tools into the district online HIS reporting system. Whereas, the PHISICC registers were designed to be used in rural health facilities, the data they gathered *via* tally sheets were shared with the broader health system in monthly reports sent to the district and then national administrative levels. Based on Marcus' dictum developed in ethnographic research, to "follow the people," we followed the health worker and the reporting tool up to the health district and assessed the use of the tool there (16, 17), including different levels of the health system into our analysis. This allowed us to gain insights into how the tool is used at district level and to appreciate the needs in a second context apart from the health facility.

Results

Our transdisciplinary collaboration focused on health workers' perspectives and on their use of the tools, in a way that shifted the center of expertise about the PHISICC tools from the design and management teams to health workers themselves. As one health worker in Nigeria said: the "PHISICC tool has become part of me." The repeated interactions between social scientists, designers, public health researchers, health workers and health managers, including monitoring and evaluation officers, led to the construction of a shared, practical knowledge in which multiple fields of practice were syncretised through the tangible modification of an intervention. We report our findings in four sections: (1) the PHISICC tools and health workers processes; (2) design issues in the PHISICC tools; (3) re-design of PHISICC tools; and (4) work at district level.

PHISICC tools and health workers processes

The PHISICC design and management team expected that certain aspects of the PHISICC tools could affect health workers' behavior in data management and clinical care. In the domain of data management, a new approach to monthly reporting was designed. In the usual approach, at the end of each month health workers have to fill a monthly report covering all health care activities carried out during the month. To complete this report, health workers have to browse through the various registry books in order to count the items that are included in the report (e.g., number of pregnant women by age group, number of vaccinations of each type of vaccine). In the case of vaccinations, in most sites they use tally sheets as vaccination activities take place, which are summarized at the end of the month without needing to go back to the vaccination registry. In PHISICC health facilities, we implemented tallying mechanisms in all health care areas, with the intention to reduce for the health

workers the workload of having to access all registries again at the end of the month.

In both countries, there was a generalized welcoming of the new tallying and reporting procedures. However, the adherence to this process of seamless tallying (i.e., tallying at the end of each clinical encounter) was not universal (see section below). These processes only changed behavior in a limited and inconsistent manner. Discussions with health workers in the HF Labs revealed that this deeply routinized end-of-month scrutiny of registers is difficult to shift and not necessarily considered problematic or seen as a cause of data quality issues.

In the health care domain, one of the key features of the tools was to provide health workers with visual clues to signal severity and hence support referral decisions. Health workers reported that they sometimes felt stuck between a rock and a hard place when complying with the demands of the health system and fulfilling the expectations of the local populations alike, while still needing to deliver high quality health care. During one of the co-creation workshops, health workers shared their dilemma to provide treatment when they actually have to refer cases, if they go by the book. Transportation costs are often high for families. Hence, they expect rural health workers to provide treatment. Health workers also fear for their reputation in the village as professionals, if they refer fever cases that are generally considered by communities as not dangerous, i.e., not needing hospital treatment. Furthermore, particularly when it is late at night or on holidays, patients risk not getting higher-level health care in the next urban place. In short, health workers feel sometimes obliged to treat cases that they should actually refer. In order to protect themselves from the anger of the community members, they may provide treatment whereas the recording of patient data (e.g., temperature values) is arbitrarily modified to justify local treatments without causing controversy, which challenges the use of the PHISICC tools. In other occasions, even if the "referral" alerts seemed to work, additional challenges may jeopardize the provision of care. A health worker reported, for example, that at the very beginning of the COVID-19 crisis, an ambulance to refer a patient with respiratory difficulties only reached the health facility hours later. Unfortunately, the patient died later in town. The population got extremely angry, besieged the health facility and threatened health workers. With the intervention of the police and negotiation of community leaders, the situation eventually calmed down.

Design issues in PHISICC tools

Health workers appreciated the standardization of the tools across different health care areas. This made it possible to build common concepts across health care areas (e.g., the standard clinical pathway, from anamnesis to clinical examination, diagnosis and treatment; the importance of vital signs; signs of severity that may suggest referral). The PHISICC recording tools had three main different concepts: the clinical course, the lifeline and the tabular formats. The former consisted of distributing the main clinically relevant data items in an organized way across a page, taking into account the flow in the process of care throughout all the required visits. It was present in antenatal care, delivery, sick child, HIV, tuberculosis and referral. The lifetime design was used only for childhood vaccination. The tabular form, not radically different from the usual paper tools, was used in postnatal care and general consultation records. Arguably, the most favorite PHISICC tool among the health workers in Nigeria was the vaccination register:

> "You only have to tick the boxes." (Health worker, Nigeria)

> "It is easy to locate a client in the register using the book and page number." (Health worker, Nigeria)

> "It is easy to carry around; it serves as a companion when going on home visit." (Health worker, Nigeria)

The main challenge of the vaccination form was that, for the "lifetime" concept to work, it was paramount that the information of a given child coming for subsequent vaccines be recorded where the child was registered in the first instance and to have a good grasp on estimating ages based on date of birth, even if approximatively.

While the PHISICC's overall design concept, which prioritizes supporting health workers' decision-making alongside quality data collection, was highly valued by health workers, several features of the tools were revealed to be challenging in their daily use by health workers themselves. Health workers pointed at some data items that were missing and that needed to be incorporated. For example, there was no space to include new vaccines in the vaccination register. This issue came up when measles booster vaccine at 15 months was introduced into Nigerian National immunization schedule for children (18). They also mentioned the required additional space to accommodate antenatal care consultations, given the WHO recommendation to expand from six to eight consultations per pregnancy (19).

> "Fully immunized should be 15 months. Extra spaces should be created for new vaccines that may be added to the immunization schedule." (Health worker, Nigeria).

Health workers in Côte d'Ivoire requested to insert an extra space for the hour of the referral, in addition to the date. This is because, when they refer patients, it may take the family some time to bring up the money to actually start moving to the next town. In unfortunate cases, the patient dies and in case

of a subsequent investigations, health workers would have the possibility to show proof of the hour the patient was referred.

There was actually a difficult choice between reserving space for changes and adaptations, which could be implemented even manually, and using the available space for clinical data considered relevant at the time of the ideation and production. The formal consistency of the design is essential to keep the visual language and its functionality. Hence, there were rather very limited alternatives to contemplate potential changes in health care recommendations in the future. One example of "manual" adaptation was from Côte d'Ivoire, where health workers used signs to mark HIV positive patients in a veiled/obfuscated manner, to ensure other patients will not be able to see the status of the previous patient during the consultation, when looking over the desk.

An issue that was present all along the design phase of the tools was the need to gather all information about the same client on the same page, particularly for those health care areas that require successive encounters for any client; i.e., antenatal care, postnatal care, vaccination, tuberculosis and HIV. While this is desirable from a clinical point of view, it entails a certain level of effort to search back in the register book every time a client shows up for any of those health care areas. This may be particularly challenging for health workers in large health facilities, with many clients and where information on current clients may span across several books. The advantage was that common data (e.g., name, contact details, basic biodata) does not need to be repeated at each consultation. This was highly valued by health workers:

> "We only register the patient once at their first visit." (Health worker, Côte d'Ivoire)

> "There is no repetition of biodata when client comes for subsequent visit." (Health worker, Nigeria)

> "There was a link with the home-based card which made it easier to trace clients as they come for subsequent visits (vaccination register)." (Health worker, Nigeria)

> "We note the register and page in the home-based record. This allows us to find the patient easily in the PHISICC book." (Health worker, Côte d'Ivoire)

Besides the obvious gains, also referred by health workers, in time used for data recording, health workers identified other possibilities to further reduce the data recording efforts; e.g., using carbon copies:

> Referral booklet "-should be made triplicate to reduce repeated writing of information and time wasting." (Health worker, Nigeria)

Carbon copies were considered at the beginning of the design process but not implemented due to cost implications and potential issues with the quality of the copies.

The redesign of PHISICC tools

The redesign of PHISICC tools took place based on feedback from health workers, which the team translated into designs through a process of "triangulation." Decisions about design improvements resulted from the combination of health workers' practical experience, an anthropologist's interpretative take on the social and institutional interactions observed, public health experts' assessments of established clinical protocols, and a designer's ability to translate those combined perspectives into literal, tangible changes to the design of the tool. In this way, the (re)design of the intervention was not removed (in time and space) from field research and health workers themselves but directly integrated into the process of observation, analysis and critique.

The HF Labs research and co-creation sessions resulted in a series of important modifications to the PHISICC tools. The OPD and PNC registers were prioritized because these were the two health care areas where the implementation of the PHISICC design concept was limited and the tabular structure of the usual tools kept.

- The PHISICC OPD was modified to more closely resemble the design principles established in the other registers. The modified version provides more guidance for decision making, reorders the sequence of findings and arranged data collection to be more in keeping with the order of OPD consultations with patients. Consequently, the number of patients per page decreased due to the changes above (see Figure 2).
- The PHISICC PNC register was modified in order to contain only one client per page, providing health workers with more space to consider the patient presentation and make tool-guided decisions based on that presentation. The previous version contained 30 clients per page (see Figure 3).
- The monthly data tallies were designed as separate single sheets, for each health care area. They were redesigned so that they could be bound into books by health care area. The intent was to simplify the storage of the tools (i.e., the tallying/reporting sheet) and make sure the separate tally sheets, which health workers said were difficult to handle individually, do not get lost.

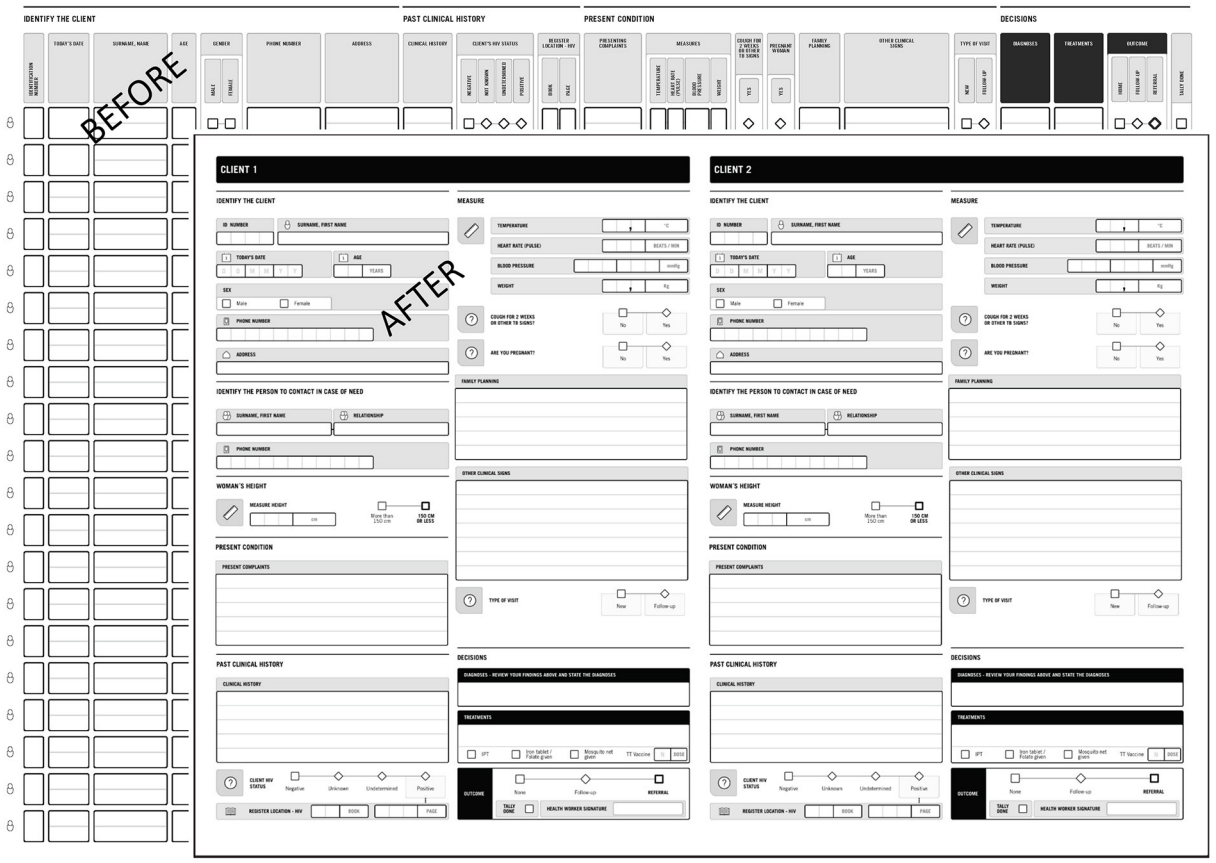

FIGURE 2
PHISICC outpatient register, before and after the series of co-design sessions.

- The antenatal care (ANC) register kept the same structure and overall design but incorporated health workers' feedback by changing the orientation of "Date for next visit" field to the end of the visit, adding decimals spaces for "Weight", adding the "Heart Rate" field, and adding a visual divider between systolic and diastolic values in the "Blood Pressure" item.

The re-designed OPD and PNC tools reduced the number of clients/patients per page to one. This has disadvantageous implications for retrieval and archiving of information because more paper may need to be used. However, we have also to consider that (a) we substantially reduced the overall size of the books to DIN-A3; (b) we reduced the number of registers (e.g., in Nigeria we canceled the general registration book at entrance, which provided no additional value to the whole information setup); and (c) regular books are often only partially filled in because of inconsistent data items, or because some pages are left blank to indicate sections within registers.

At district level

The PHISICC tools, although focusing on primary health care health facilities, had to convey information to the district level through the monthly reports. Hence, both the mini-beta and the early stages of the trials required the involvement of actors at higher levels of the health system, the main issue being the inclusion of initially missing indicators into the PHISICC tallies and reporting tools. In particular, it was ensured that the indicators being reported at the facility level were aligned with the needs and expectations of the regional and national HIS. Although the project engaged the Ministry of Health at the highest levels from the start of the PHISICC project, there were communication challenges at the beginning of the implementation phase in Côte d'Ivoire, partially due to the COVID-19 situation. Whereas, the rural health facilities as well as the Ministry were well-informed, regional and district levels were not sufficiently associated at trial implementation. The supervisors of the health workers in Côte d'Ivoire lacked training on how to use the tools, as they had not been part of the training sessions. Furthermore,

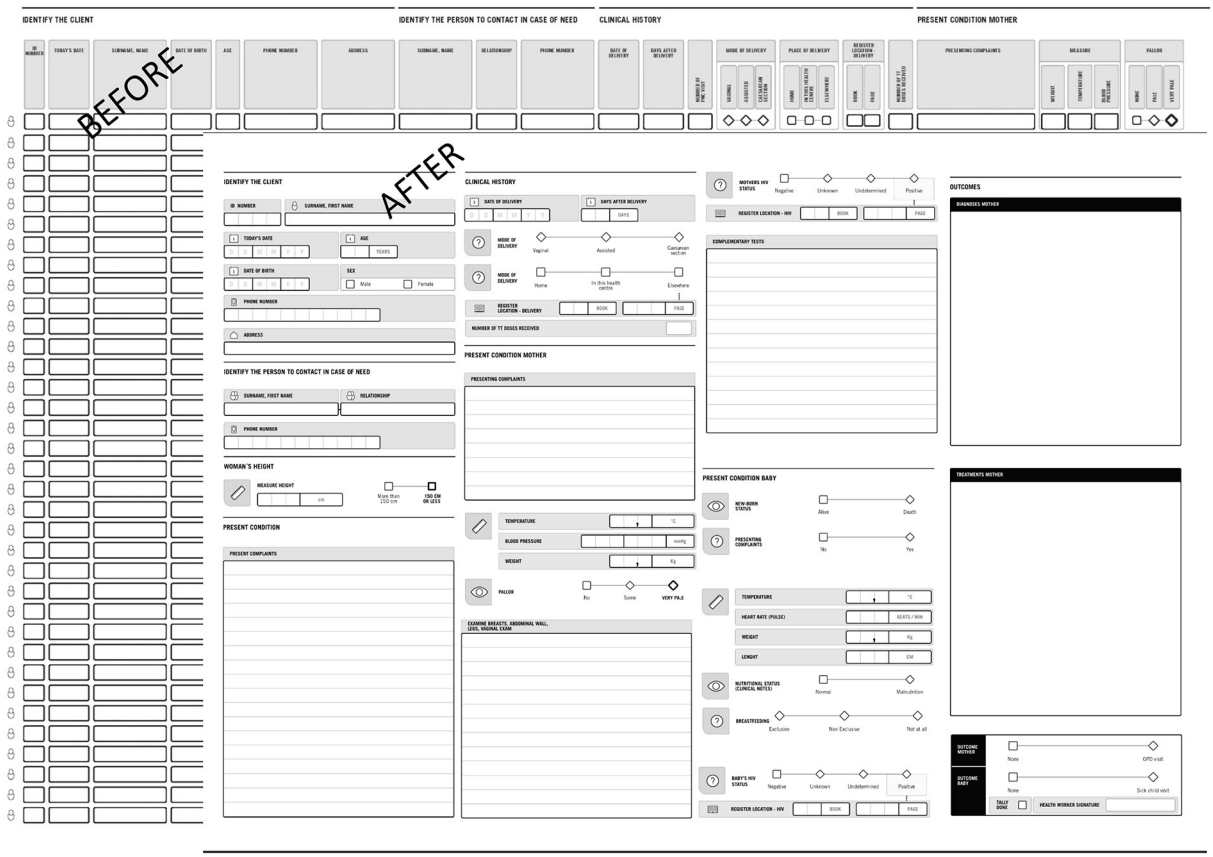

FIGURE 3
PHISICC postnatal care register, before and after the series of co-design sessions.

the format of the indicators of the new reporting tool did not perfectly match with the online reporting tool at district level. Within the district, health workers quickly delivered the missing indicators to the district by using a separate list or filing in national reporting forms that covered information that the tools initially did not. To improve the smoothness of the trial, a workshop was organized during which the region and districts were represented. This process allowed the project to include indicators of the national system into the PHISICC tools, making them fully compliant with the data requirements of the system.

In Nigeria, there was engagement of the Ministry of Health at the three tiers of government—Federal, State and Local Government Area from the start of the PHISICC project. However, at the beginning of the implementation of the project, there were challenges in the monthly reports. Similar to the situation in Côte d'Ivoire, the PHISICC summary sheet did not match the online reporting tool used at the district level. To overcome this problem, health workers at the facility were made to submit 2 monthly summary forms, the PHISICC form and the National Health Management Information System forms. This was seen by the health workers as double work for them. To overcome this challenge, extra support in terms of training in the PHISICC report was provided to the district monitoring and evaluation officer by the PHISICC team. Thereafter there was seamless entry of data captured from the PHISICC summary sheet to the state database.

Discussion

PHISICC in the context of health systems

The PHISICC paper-based system can be seen as a moderately or highly complex intervention (20): it has several components (i.e., recording, counting, reporting), several targets (i.e., data collection, clinical decision-making, follow-up), it embraces several system levels (i.e., primary health care and districts), with little flexibility in its implementation, requiring considerable skills for health workers using the information and basic skills for users of health services

providing the information. HIS, as any other intervention affecting the health system, may impact on how health care is planned and delivered and may ultimately influence the health of the population. Yet, despite the existence of some examples of evidence-informed recommendations (21), health systems interventions lack the regulatory mechanisms of pharmaceutical interventions (22), that protect communities from systems harms. Our challenge from the outset of the PHISICC research programme was to incorporate professional (systems) design in the intervention ideation and development, within a complex research programme.

The WHO Health Systems framework considers "system-design" in the "leadership and governance" building block; however, there are no further explanations in the document (23). We could not really draw much from it. Our systems thinking was rather influenced by the sustained observations, conversations and collaborations with health care workers themselves, which triggered a relocation of systems components from what we initially conceived: emphasizing health care over data collection; the use of data over the collection of data; the decisions made with data over the quantity of data collected; and the concerns of rural and underserved health facilities over the concerns of managers charged with overseeing those facilities.

HF labs contributions

The HF Labs were the space for those structured, productive collaborations between a transdisciplinary team, which combined domains of knowledge including public health, health information, anthropology, sociology, design strategy, and interaction and graphic design, with the practical experience and pragmatic knowledge of health workers. The HF Labs, focusing on qualitative and HCD methods, were not equipped to address intervention effectiveness questions (24). However, we value the evidence suggesting that PHISICC made a substantial qualitative improvement in the working lives of the health workers: they were appreciated and seen as support tools in the delivery of protocol-driven, quality health care.

The HF Labs experience has shown that it is possible to engage in sustained iterative improvements of a system intervention simultaneously with a rigorous trial of the effectiveness of that intervention. Complementing trials with qualitative evidence is becoming standard practice, particularly in health systems interventions and in systematic reviews (25) that eventually inform policies. By "setting aside" a small number of sites where the intervention was being used during the broader RCT, the HF Labs provided practical, qualitative assessments of the tools by health workers, produced explanatory evidence that deepened our insights on how the PHISICC intervention may work and created an opportunity to improve the intervention.

We believe that two main issues may explain the success of the HF Labs in both producing explanatory evidence and in providing clues for improvements, at the same time. On the one hand, the transdisciplinary approach made it possible to refocus the PHISICC intervention toward quality of care, taking into account socio-cultural attitudes and expectations as well as economic and geographical constraints of communities, putting people at the center of Health Policy and Systems Research (26). Secondly, the HCD approach provided a solid mechanism not only to understand how the PHISICC intervention could work but also to actually operate a tangible improvement of the intervention informed by the evidence collected: "Design is essentially a practical and pragmatic discipline that combines knowledge creation and knowledge use" (27). This set-up was quite unique in its format and in the mix of expertise involved. While the HF Labs were conceived in the context of research, we hypothesize that they can be valuable routine mechanisms to monitor and improve the usability of health systems interventions by health workers.

Health systems thinking and health systems failures

Both in Côte d'Ivoire and in Nigeria, frontline health workers are requested by health programmes and external projects and donors to collect more data. Ministries of Health authorities were well-acquainted with this issue although with limited capacity to address it, likely due to the competing interests of many parties. They were, though, part of the PHISICC research team (6) and we would consider them to be enthusiastic with the prospects of considering simplification and user-friendliness in the routine data management procedures.

However, despite all the care taken to account for the health system setup and broad context, we also experienced "system failures," some of which, we believe, were hardly possible to anticipate; for example, there were reports of external interferences from vertical programmes even in PHISICC intervention health facilities; or the fact that the very same data items that facilitated clinical care and patient treatments could be seen as a controlling mechanism in the context of clinical audit that brings penalisations, resulting in a situation that cannot be appropriately handled by the system (e.g., an aborted referral). These real-life situations may escape systems thinking considerations to the extent that its analytical capacity, and that of the underlying framework, remains limited.

Health systems challenges are indeed gigantic, particularly in LMIC (28), and have been in the research and development agenda, in one way or another, for years (29). Despite the consensus that systems thinking may have a role in health systems strengthening initiatives, there is limited evidence

demonstrating how systems thinking has been practically applied to solve real-world health system challenges (30). It may be that health systems thinking is too specific to a particular health systems framework [e.g., in terms of "building blocks" (23)] and cannot negotiate, for example, a broader set of topics to inform health systems research syntheses (31); it may be that systems thinking tries to attain too large a range of concepts and tools that jeopardizes its consistent application, even in research settings (32); or it may be that systems thinking is not sufficiently developed to hold the multiple dimensions of health systems governance (33), delivery (34) and financial (35) arrangements and implementation strategies (36) together.

The human centered design in practice

Shadowing is an established HCD technique used to both observe participants in the context in question and to enter into a dialogue with participants as they do the work. Although it could alter the behaviors of those observed, when done tactfully and intentionally, it creates a productive dialectic between activities and verbal reflections on those activities. The reflections' "proximity" to the activity in question allows both the participant and the researcher to investigate minute details of the activity, challenges, and work practices which may be glossed over or lost during recall or an interview conducted "not in-context".

We hypothesize that HCD can address system failures through a pragmatic approach, using "design thinking" to bring solutions where problems cannot wait. HCD, put into practice by transdisciplinary teams in co-creative dialogue with actual people in the system, may be just the approach to produce interventions that can operate in real-life situations. The HCD method used in the PHISICC project placed frontline health workers and health facility patients at the very center of our research, analysis, and design (26). Health workers are often alone and feel fragile in the midst of a population that often considers them as outsiders to their communities; and any research that aspires to improve the quality of care has to embrace the human factor. We believe that we have shown a way of doing that.

This tangible, people-centered focus on interventions also shifted the team's own perspectives, from the more traditional system-wide, top-down analysis of health data, data collection processes and data quality to health workers themselves. Our co-creative, HCD approach focused the team's work at the very point in the system where healthcare happens *before* it becomes data *about* that care. In this way, HCD methods contribute to the practice of systems theory in that they provide a replicable method for translating the multi-perspective insights inherent in the mapping of complex systems like health information systems into tangible, material interventions that incorporate the inputs of participants in, and observers of that same system.

Research in remote areas

We would like to briefly mention the challenges of carrying out research in remote rural areas, including the availability of staff for training (already in shortage at their workplaces), staff turn-over, transport and communication means, living conditions, weather and geographical barriers. There does not seem to be a lot of evidence on the challenges of research in remote areas and on strategies to cope with them (37). This was only worsened by the COVID-19 pandemic because during this period the health workers were asked to focus on COVID-19 vaccination, leading to general disruptions in the use of routine health services and in the provision of healthcare during the period of the lock-down. Exchanges between research teams from Côte d'Ivoire and Nigeria were also affected by these restrictions. Only the commitment of the team to contribute to improving the lives of underserved communities could overcome those gigantic obstacles.

Conclusion

HF Labs may serve as a model for how transdisciplinary design research, centered on the perspectives of health workers, can lead to the creation of a health system intervention, which, once produced and used for an extended period of time, can be further evaluated and improved, within a wider research programme. HCD can operationalise health systems thinking into health systems interventions operating in real-life situations, even in the absence of a fully developed and consistent health systems framework.

While we value and share the recently issued recommendations on health systems thinking (30), we would advocate for considering HCD approaches for the ideation, testing and implementation of interventions to improve health systems and health status outcomes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by In Côte d'Ivoire: Comité National Ethique des Sciences de la Vie et de la Santé – CNESVS; in Nigeria: Government of Cross River State of Nigeria, Ministry of Health, Calabar Health Research Ethics Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

XBC, DR, and DO were instrumental in the development of the concept and design of the study. NE, KH, ON, SB, SA, GE, and VU interacted with the health workers and other stakeholders in Côte d'Ivoire and Nigeria, respectively and gathered the data in the field. DO and DR guided the fieldwork remotely. XBC coordinated research teams, commented and provided substantial inputs to the research protocol, report of findings and manuscript. CA commented and provided substantial inputs to the research protocol, report of findings and manuscript. GBG supported the field work in Côte d'Ivore and AOI in Nigeria; both significantly contributed to the manuscript. All authors substantially contributed to conception and/or development of the study and the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Social position and economic system justification in Canada: Implications for advancing health equity and social justice from an exploratory study of factors shaping economic system justification

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Objective: Many socio-economic reforms that could reduce health disparities are not implemented because people justify existing systems and fear changes thereto. This study aimed to identify socio-demographic factors associated with system justifying beliefs to better understand how they are maintained in Canada. In doing so, we hypothesized that (1) systems justification is a default cognitive position, buttressed by the palliative benefits of system-justification, (2) lack of success in a given system generally motivates people to doubt the legitimacy of that system, and (3) system-justifying beliefs are rejected only when the costs of doing so are low enough and/or the benefits are high enough to outweigh the innate needs-fulfillment benefits of system-justification.

Methods: Testing these hypotheses, we recruited participants living in Canada, aged 16+, to complete an online survey after being recruited *via* paid social media advertisements. Multivariable regression models identified factors associated with Economic System Justification Scale (ESJS) scores. Explanatory variables included demographic measures of social position, self-rated health, and patterns of social inclusion.

Results: Among 2,619 participants, system-justifying beliefs were wide-spread, with the average level of support across ESJS scale items exceeding 50%. Lower ESJS scores were associated with worse health, more loneliness, and lower socioeconomic status. Despite the pattern that marginalization erodes system-justification, several historically marginalized characteristics (e.g., non-white ethnicity and non-binary gender) were associated with relatively high system-justification, compared to matching privileged characteristics (e.g., white ethnicity; masculine gender).

Conclusion: Supporting our hypotheses, we identify a general trend that social marginalization is associated with less system-justification. Those benefitting from the status quo (e.g., healthier, wealthier, less lonely) were more likely to

hold system-justifying beliefs. However, some groups who are disadvantaged within the existing system reported higher system-justification—suggesting that system oppression may be a key moderator of the effect of social position on system justification.

KEYWORDS

status quo bias, economic system justification, health equity, wellbeing, social position

Introduction

Many social and economic reforms that are designed to reduce health disparities are not implemented because they lack public support (1, 2). A common barrier to amassing public support for such policies is the public's preference for existing systems and aversion to change. This phenomenon has been referred to as "status quo bias" (3, 4). As an example, neoliberal beliefs about personal agency, behavior, responsibility, and accountability justify existing health and social systems because they presuppose that health disparities are the product of individual choices and not systemic inequalities; and therefore, changes to the system are not needed (5, 6).

According to System Justification Theory, biases in favor of the status quo—and the political ideologies that rationalize these biases—arise from basic human needs: the need for a general sense of stability, certainty, and predictability; the need to belong; the need to understand the world and one's place in it; and the need to feel good about one's self and community (7–9). Material and tangible benefits of social conformity and performativity also likely support system-justification. In other words, people are cognitively motivated to construct and uphold system-justifying beliefs because these beliefs aid and pacify innate human needs (10). Thus, ideological support for systems can be interpreted as a default *post-hoc* rationalization that allows individuals to benefit from existing systems and structures without cognitive dissonance for the harms these systems cause (11, 12). Unfortunately, this phenomenon poses a considerable obstacle to the sort of social and economic change that is needed to address health disparities (13).

Of course, there are many people who do not believe that the status quo is justified. So, how do we explain the emergence of these system-challenging beliefs in the presence of status quo bias? One explanation, informed by rational choice models of political behavior, is that people who are better pacified by a given system are more inclined to maintain system-justifying beliefs; while those who are disadvantaged by a given system are inclined to shed these beliefs and seek out reforms (14, 15). For example, while majorities of people widely believe health inequities are driven by traditional health determinants (e.g., *personal knowledge and health behaviors*), those from marginalized backgrounds are relatively more likely to endorse the importance of social determinants of health [e.g., *one's economic and social position* (16)]. This explanation supports the basic premise of System Justification Theory—that political ideology represents a form of motivated social cognition (17, 18)—while also helping us to understand the correlation of social position and system-justification. Indeed, while people generally accept system justifying beliefs (*such as the belief that health is driven by individual and not systemic causes*), their lived experience appears to override status quo bias. This may be because the cognitive and personal costs of system-justifying ideologies outweigh the benefits of supporting the system when one's position in it is disadvantaged (19).

While it is plausible that social position may provide a cognitive motive for rejecting system justification, several studies have found that systematically oppressed individuals in a given system are actually more likely to hold system-justifying beliefs compared to those with relative privilege (20–22). For example, data from Pew Research Center shows that Black Democrats are considerably more moderate than white Democrats (23) and the Survey Center on American life shows that White liberals favor defunding the police more than Black and Hispanic Americans (24). Similarly, low-income uneducated white voters are more likely to support Republicans than high-income educated white voters (25). Finally, van der Toorn et al. (9) showed that people who feel most powerless believe most strongly in the legitimacy of governments (26). In each of these comparisons, social marginalization appears to be associated with stronger system-justifying beliefs: giving rise to what has been referred to as the "status legitimacy hypothesis" (22)—which is a surprising contradiction to our rationale choice hypothesis that people underserved by a system will be motivated to hold beliefs that support system-change.

Based on these various (seemingly contradictory) findings, three hypotheses are advanced about system-justifying beliefs: First, status quo bias is a default cognitive position, buttressed by the palliative benefits of system-justification (8). Second, lack of success in a given system generally motivates people

to doubt the legitimacy of that system (27). Third, system-justifying beliefs are rejected only when the costs of doing so are low enough and/or the benefits are high enough to outweigh the innate needs-fulfillment benefits of system-justification. This three-part hypothesis may explain why some markers of social disadvantage are associated with high levels of system justification, despite the general trend that people underserved by a system are motivated to doubt its legitimacy. Put another way, marginalization promotes system- challenging beliefs, until it doesn't—until it oppresses these beliefs. For example, if challenging the system comes at a higher price for marginalized individuals than it does for privileged individuals, our three-part hypothesis would suggest that the marginalized group would be more strongly motivated to justify the system. In other words, the privilege of belonging to a privileged group would allow one, ironically, the freedom to reject the system which privileges her. Conversely, oppressed minorities may be oppressed into acceptance of the status quo. If true, conflicting findings about the status-legitimacy hypothesis likely arise from specific social processes within specific systems (22). It is thus important to identify which markers of social position are associated with system-justifying and system-challenging beliefs to understand the underlying social processes that must be addressed to generate consensus about the need for social change. Therefore, the present study aims to explore which dimensions of social position facilitate the rejection of system-justifying beliefs and which are associated with higher system-justification. In so doing, this exploratory study will (1) add to the empirical evidence regarding System Justification Theory, (2) empirically explore the validity of the status-legitimacy hypothesis (which posits higher system-justification among marginalized individuals compared to privileged individuals), and (3) demonstrate the relevance of these theories to the contemporary Canadian context.

Methods

Study setting

Study context

The present study aims to explore system justifying beliefs in Canada. While Canada is a relatively free, liberal democracy, it is also strongly influenced by the white, Anglo-Saxon, Protestant heritage of the settler-colonial government (28, 29). Canada's social and political system shares much with its southern neighbor, the United States, though Canada's political history and current trajectory has created a different system of social relations—particularly in the development of its conservative political movement (30). For example, religious, anti-state conservativism in Canada is significantly less potent (30–32)—leading to radically different outcomes across several leading cultural contests [e.g., gay marriage, gun control, abortion, unions, immigration (33–36)]. Further, all of the country's major political parties espouse support for pluralism, multiculturalism, and social equality (37–40); and since the 1980s, the *Canadian Charter of Rights and Freedoms* has provided a robust modern framework for human rights protection in Canada (41). Nevertheless, it is well-documented that the Canadian system favors mainstream, populist interests (42, 43) that marginalize Black, Indigenous, Muslim, French-speaking, and other racialized minorities and ethnic groups (40, 44, 45). Despite this, Canada's centrist party (i.e., the Liberal Party) continues to out-compete relatively more progressive entities for electoral support from these groups—a fact that boosts its reputation as "Canada's natural governing party" (46–48). Notably, social mobility is declining in Canada and inequality is increasing—though Canada compares relatively well on both indicators to the United States (49, 50). In a June 2020 report from the Parliamentary Budget Officer, the top 1% of Canadians control approximately one-fourth of the nation's wealth (51)—and the politics of wealth distribution in the country have remained relatively stagnant since the 1990s (52). Given these realities, Canada provides a unique and interesting setting to study system-justification and test the hypotheses outlined in this paper's introduction.

Data collection

Data for this study was drawn from an online convenience sample conducted between May and June 2020. Participants were residents of Canada, 16 years of age or older, who were recruited using paid advertisements on Facebook and Instagram. Participants who completed the survey were entered into a prize drawing for $400 CAD. Advertisements were posted in English and French and directed participants to a Qualtrics survey available in either language. Upon initiating the survey, each participant was screened for eligibility, provided informed consent, and completed a 20-min questionnaire.

Outcome variable

The Economic System Justification Scale (ESJS) was used as a general measure of system-justifying beliefs (53). Scale items for the ESJS are provided in Figure 1 and were scored on a 4-point Likert scale: Strongly Agree, Agree, Disagree, Strongly Disagree. In brief, these items measured participant's attitudes about the legitimacy (e.g., "*Economic differences in the society reflect an illegitimate distribution of resources*"), naturality (e.g., "*Laws of nature are responsible for differences in wealth in society*"), and inevitability (e.g., "*It is virtually impossible to eliminate poverty*") of the economic system. The Cronbach alpha score for the scale was found to be high ($\alpha = 0.90$) and final

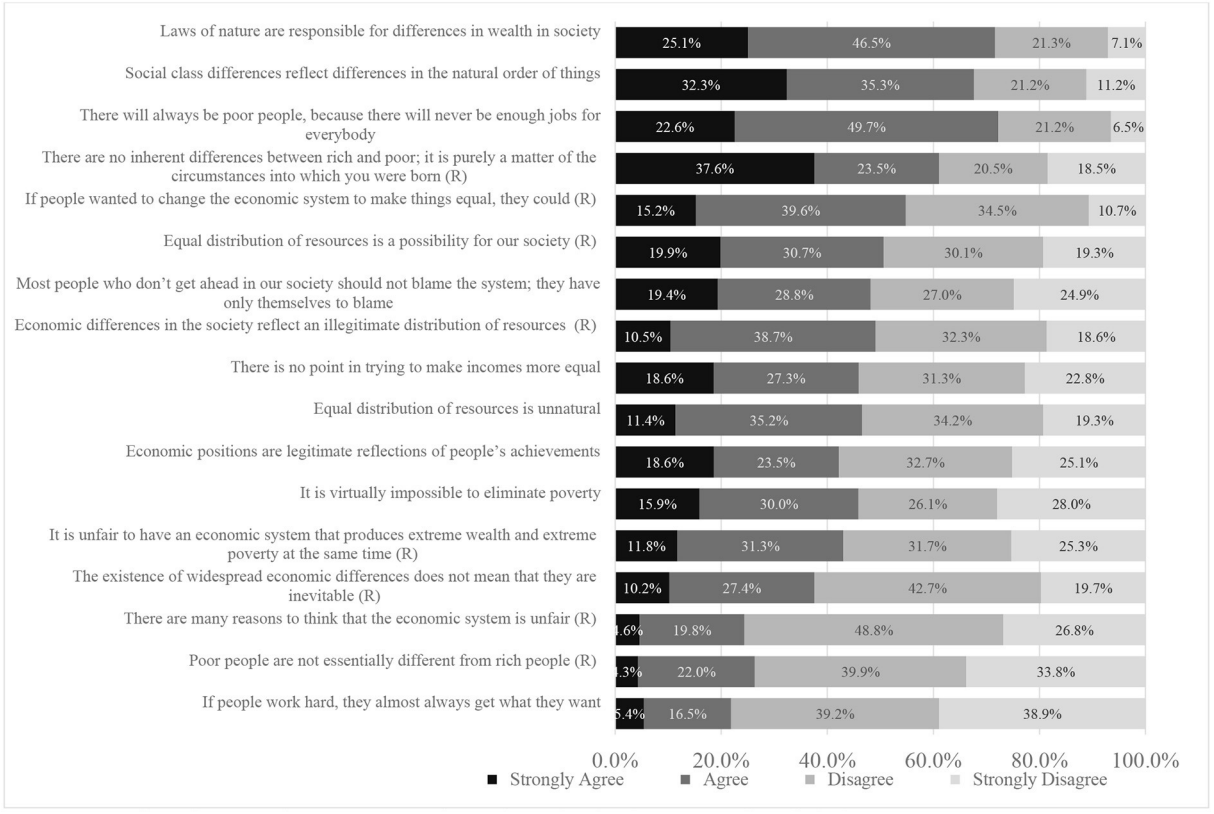

FIGURE 1
Economic system justification scale (ESJS) items. (R), Reverse Scored (i.e., Higher agreement indicates lower levels of system-justifying belief).

scale scores range from 17 (lower system justification) to 68 (higher system-justification).

Explanatory variables

To measures aspects of a participant's social position, a demographic questionnaire was completed. This questionnaire assessed participant's age, gender identity, sexual orientation, ethnicity, relationship and family status, disability status, income level, education level, occupation classification, housing situation, province of residence, geographic rurality-urbanity, religious affiliation. These factors were selected from a list of pre-determined options, aligned with the Canadian Census. Participant's self-rated health and experiences of loneliness were also included. To assess self-rated health participants were asked "In general, would you say your health is…Excellent, Very Good, Good, Fair, or Poor?" The 3-item UCLA loneliness scale [Study $\alpha = 0.86$; (54)] was used to assess loneliness. This scale asks participants how often they feel they "lack companionship?" "left out?" and "isolated from others?" Each question is scored on a three-point scale (1) "Hardly Ever," (2) "Some of the time," or (3) "Often." The sum of scale items is calculated, and higher scores represent greater loneliness.

All variables were self reported except the geographic rurality and urbanity, which was based on data from the Canadian Census and linked to participant responses using their forward sortation area code (i.e., the first three digits of their Canadian postal code). Based on World Bank practices, participants living in forward sortation areas with a population of <300 people per square kilometer were classified as being rural, participants living in regions with more than 1,500 residents per square kilometer were classified as being urban, and participants living in between these values were classified as being suburban (55).

Data analysis

Analyses were conducted in R version 4.1.2. (56). Multiple imputation using fully conditional specification implemented using the MICE algorithm described by Buuren

and Groothuis-Oudshoorn (57) was used to impute missing data on explanatory variables using the mice package (57, 58). This approach allowed for imputation of each variable independently using regression based equations. For all variables, five imputations were conducted using the cart method (i.e., classification and regression trees, with up to 250 iterations per imputation. Imputation did not affect the overall findings in sensitivity analyses—suggesting that data are missing mostly at random. Observations missing the primary outcome variable were removed using listwise deletion.

To address our three hypotheses we sought to (a) examine the prevalence of system justifying beliefs by examining the data descriptively to identify how widespread support was for economic system justifications and (b) identify the characteristics that were associated with greater system justification using a multivariable framework that allowed us to identify the independent effects of each sociodemographic factor. These multivariable results were then interpreted qualitatively in order to see if greater success within the system was associated with higher system justification and assess whether any marginalized populations were more likely to endorse the system compared to their relatively privileged counterparts. Descriptive statistics were calculated for the overall sample using the tableone package (59) and the psych package (60). Separate bivariable regression models tested associations between each explanatory variable and ESJS scores. Based on these results two multivariable linear regression were conducted using base R's glm function. A linear regression was selected due to normality of distributed outcome variable and confirmation of linear regression assumptions being met in standard diagnostic plots. For multivariable regression analyses, ESJS scores were treated as the continuous outcome variable and all other variables were treated as explanatory factors. This approach enabled us to identify the independent and adjusted factors associated with system-justifying beliefs. As mentioned above, two multivariable models were constructed: the first included all variables of theoretical interest, and the second was built using variables selected *via* stepwise backwards selection for AIC minimization. AIC minimization was used to balance model simplicity and explanatory power. Results from the stepwise selected model are discussed. Notably, the full model and stepwise selected model had similar R^2-values (0.313 vs. 0.312), the differences in AIC were small (18,622 vs. 18,620), and the general conclusions reached from the models did not appear to be sensitive to the model building approach. Based on regression results, boxplots were created using the ggplot package to illustrate important relationships between key variables of interest (61).

Several additional *post-hoc* analyses were conducted by constructing boxplots to examine relationships between ESJS scores and key variables. This was done to better understand the results of the multivariable models and provide further insights into possible inter-relationships between variables, consistent with an intersectional analysis approach (62). The first, examines ESJS scores across political party affiliations. The second, examined levels of ESJS scores by health status and income. The Third, examined ESJS scores by ethnicity and educational attainment.

Results

Descriptive statistics for the analytic sample are provided in Table 1. In summary, among 2,619 eligible participants, the median age of our sample was 60.2 years. The sample was disproportionately composed of people who were women (53.6%), identified as white (74.8%), were straight/heterosexual (83.5%), were in a relationship (67.7%), had a college education (41.8%), and had incomes of $60,000 or more (53.0%). Most participants also reported owning their home (67.7%) and having good health (72.7%). Approximately one-third of participants reported living with an auditory, visual, physical, cognitive, or other disability (37.1%), half (48.6%) identified as living in rural regions of Canada, and half reported being Christian (50.9%). With respect to our first hypothesis (i.e., that system justification beliefs are widespread), we found system justifying beliefs were widespread with the average level of support across all items being 53.8% and a median score of 39 (representing a slight tendency for agreement within the whole sample).

Table 2 provides bivariable and multivariable results identifying the independent and adjusted factors associated with higher levels of economic system-justifying beliefs (as measured using ESJS scores). Regression coefficients and 95% confidence intervals are reported in table format, but not repeated in-text. With respect to our second hypothesis (e.g., that success within a system promotes system justification), our multivariable results showed that higher ESJS scores were associated with lower levels of loneliness and higher self-rated physical health. With respect to our third hypothesis (e.g., that some marginalized groups would be deterred from system-rejection due to high social costs), identifying as gender non-binary (vs. identifying as a man), non-white ethnic identification [i.e., African, Caribbean, or Black; Arab/West Asian; Indigenous; or Other Ethnic Orientation (vs. White)], higher income, better self-rated health, reporting a Christian religious affiliation, or living in the Prairie region of Canada. Lower ESJS scores were associated with identifying as a woman (vs. man); having a Bachelor's degree or higher level of education, working in civic services (i.e., Education, Law, Government, Health and Science); being retired; being a student; renting (vs. owning); reporting a non-Christian religious affiliation (i.e., Atheist, Agnostic, or

TABLE 1 Descriptive statistics.

	Overall (*N* = 2,619)	ESJS score > 39 (*N* = 1,302)	ESJS score < 39 (*N* = 1,317)
Age *Mean (SD)*	60.2 (13.7)	59.9 (14.1)	60.5 (13.3)
<30	100 (3.8)	64 (4.9)	36 (2.8)
31–59	902 (34.6)	427 (32.9)	475 (36.2)
60+	1,608 (61.6)	808 (62.2)	800 (61.0)
Gender			
Man	1,024 (39.1)	336 (25.8)	688 (52.2)
Non-Binary	190 (7.3)	53 (4.1)	137 (10.4)
Woman	1,405 (53.6)	913 (70.1)	492 (37.4)
Ethnicity			
African, Caribbean, or Black	67 (2.6)	21 (1.6)	46 (3.5)
East Asian	32 (1.2)	12 (0.9)	20 (1.5)
Indigenous	140 (5.3)	60 (4.6)	80 (6.1)
Other	391 (14.9)	117 (9.0)	274 (20.8)
South Asian	19 (0.7)	11 (0.8)	8 (0.6)
West Asian	11 (0.4)	3 (0.2)	8 (0.6)
White	1,959 (74.8)	1,078 (82.8)	881 (66.9)
Sexual orientation			
Heterosexual	2,187 (83.5)	1,105 (84.9)	1,082 (82.2)
Gay, Lesbian, Bisexual, Queer, or Other	432 (16.5)	197 (15.1)	235 (17.8)
Relationship status			
Single	846 (32.3)	511 (39.2)	335 (25.4)
In a relationship	1,773 (67.7)	791 (60.8)	982 (74.6)
Educational attainment			
High school diploma or lower	425 (16.2)	203 (15.6)	222 (16.9)
Advanced training below bachelor level	1,100 (42.0)	539 (41.4)	561 (42.6)
Bachelors or higher	1,094 (41.8)	560 (43.0)	534 (40.5)
Occupation & employment status			
Management, finance, and administration	288 (11.0)	112 (8.6)	176 (13.4)
Arts, culture, and sport	46 (1.8)	25 (1.9)	21 (1.6)
Education, law, and government	249 (9.5)	141 (10.8)	108 (8.2)
Health and science	305 (11.6)	174 (13.4)	131 (9.9)
Manufacturing, trades, and resource	257 (9.8)	70 (5.4)	187 (14.2)
Sales and services	200 (7.6)	99 (7.6)	101 (7.7)
Retired	1,164 (44.4)	600 (46.1)	564 (42.8)
Student	37 (1.4)	26 (2.0)	11 (0.8)
Unemployment/disability	51 (1.9)	43 (3.3)	8 (0.6)
Unpaid care giving	22 (0.8)	12 (0.9)	10 (0.8)
Household income			
<$29,999	537 (20.5)	342 (26.3)	195 (14.8)
$30,000–$59,999	693 (26.5)	367 (28.2)	326 (24.8)
$60,000–$89,999	547 (20.9)	255 (19.6)	292 (22.2)
$90,000 or more	842 (32.1)	338 (26.0)	504 (38.3)
Housing situation			
Own	1,774 (67.7)	781 (60.0)	993 (75.4)
Rent	691 (26.4)	430 (33.0)	261 (19.8)
Other	154 (5.9)	91 (7.0)	63 (4.8)

(Continued)

TABLE 1 (Continued)

	Overall (*N* = 2,619)	ESJS score > 39 (*N* = 1,302)	ESJS score < 39 (*N* = 1,317)
UCLA loneliness score *Mean (SD)*	4.97 (1.95)	5.45 (2.01)	4.50 (1.77)
Self-rated health			
Poor	219 (8.4)	153 (11.8)	66 (5.0)
Fair	497 (19.0)	301 (23.1)	196 (14.9)
Good	930 (35.5)	458 (35.2)	472 (35.8)
Very good	735 (28.1)	320 (24.6)	415 (31.5)
Excellent	238 (9.1)	70 (5.4)	168 (12.8)
Disability status			
No	1,648 (62.9)	738 (56.7)	910 (69.1)
Yes	971 (37.1)	564 (43.3)	407 (30.9)
Religious affiliation			
Protestant	615 (23.5)	262 (20.1)	353 (26.8)
Catholic/Orthodox	424 (16.2)	172 (13.2)	252 (19.1)
Other Christian	294 (11.2)	89 (6.8)	205 (15.6)
Non-Christian	346 (13.2)	209 (16.1)	137 (10.4)
Agnostic	626 (23.9)	359 (27.6)	267 (20.3)
Atheist	314 (12.0)	211 (16.2)	103 (7.8)
Rurality-Urbanity			
Urban	796 (30.4)	412 (31.6)	384 (29.2)
Rural	1,272 (48.6)	616 (47.3)	656 (49.8)
Suburban	551 (21.0)	274 (21.0)	277 (21.0)
Region			
Ontario	876 (33.4)	467 (35.9)	409 (31.1)
Atlantic Canada	244 (9.3)	142 (10.9)	102 (7.7)
British Columbia	599 (22.9)	298 (22.9)	301 (22.9)
Prairies	758 (28.9)	304 (23.3)	454 (34.5)
Quebec	129 (4.9)	87 (6.7)	42 (3.2)
Territories	13 (0.5)	4 (0.3)	9 (0.7)

Other Non-Christian Religious Tradition); and residence in Quebec.

Post-hoc analyses of ESJS scores interesections with key variables are presented as boxplots in Figures 2, 3. Figure 2 shows that endorsement of ESJS scores are correlated with political party affiliation, but with considerable overlap of data. Figure 3 shows that within each income group, higher self-rated physical health is associated with higher economic system justification. Figure 4 shows that the relationship between educational attainment and ESJS scores differ by ethnicity—particularly for African, Caribbean, and black people for whom there appears to be a positive relationship between educational attainment and higher ESJS scores.

Discussion

Primary findings and relationship to existing studies

The present study aimed to examine which dimensions of social position were associated with system-justifying beliefs. Our intention was to understand better how system justification arises and prevents the emergence of reforms that would promote health equity for marginalized people and the overall improvement of health among Canadians. In doing so, three hypotheses were advanced about system justifying beliefs suggesting (1) that system-justification beliefs would be widespread—reflecting their role as a default bias in favor

TABLE 2 Regression models identifying associations with higher economic social justification scale scores.

	Bivariable models testing associations between each explanatory variable and ESJS scores		Multivariable models testing associations between all backwards stepwise selected variables and ESJS scores	
	β	95% CI	β	95% CI
Age	0.02	−0.01, 0.05	Not selected	
Gender				
Man	Reference		Reference	
Non-Binary	1.32	−0.13, 2.76	**1.68**	**0.01, 3.36**
Woman	**−7.13**	**−7.88, −6.37**	**−5.4**	**−6.12, −4.68**
Ethnicity				
White	Reference		Reference	
African, Caribbean, or Black	**6.95**	**4.57, 9.33**	**7.00**	**4.87, 9.13**
Arab/West Asian	**6.98**	**1.19, 12.77**	**7.02**	**1.97, 12.07**
East Asian	3.07	−0.34, 6.49	1.87	−1.12, 4.85
Indigenous	**3.18**	**1.51, 4.86**	**2.83**	**1.36, 4.30**
South Asian	0.65	−3.77, 5.07	2.22	−1.62, 6.05
Other	**5.8**	**4.74, 6.86**	**3.42**	**2.44, 4.41**
Sexual orientation				
Heterosexual	Reference		Reference	
Gay, Lesbian, Bisexual, Queer, or Other	**1.04**	**0.01, 2.08**	−1.22	−2.38, −0.06
Relationship status			Not selected	
Single	Reference			
In a relationship	**3.43**	**2.62, 4.24**		
Educational attainment				
High school diploma or lower	Reference		Reference	
Advanced training below bachelor level	0.53	−0.59, 1.66	−0.33	−1.29, 0.64
Bachelors or above	−0.24	−1.36, 0.89	**−2.08**	**−3.11, −1.06**
Occupation & employment status				
Management, finance, and administration	Reference		Reference	
Arts, culture, and sport	**−3.37**	**−6.42, −0.32**	0.06	−2.60, 2.73
Education, law, and government	**−4.76**	**−6.42, −3.1**	**−2.84**	**−4.28, −1.40**
Health and science	**−4.11**	**−5.69, −2.53**	**−1.98**	**−3.34, −0.61**
Manufacturing, trades, and resource	**2.43**	**0.78, 4.08**	0.72	−0.73, 2.17
Sales and services	**−2.45**	**−4.22, −0.69**	−0.49	−2.04, 1.06
Retired	**−2.78**	**−4.04, −1.51**	**−1.26**	**−2.40, −0.12**
Student	**−7.37**	**−10.73, −4.01**	**−3.94**	**−6.89, −1.00**
Unemployment/Disability	**−8.79**	**−11.71, −5.87**	−2.46	−5.06, 0.14
Unpaid care giving	−3.65	−7.9, 0.6	0.58	−3.10, 4.26
Household income				
<$29,999	Reference		Reference	
$30,000–$59,999	**2.42**	**1.31, 3.53**	0.8	−0.19, 1.79
$60,000–$89,999	**3.59**	**2.41, 4.76**	**1.59**	**0.50, 2.68**
$90,000 or more	**5.02**	**3.96, 6.09**	**1.44**	**0.36, 2.52**

(Continued)

TABLE 2 (Continued)

	Bivariable models testing associations between each explanatory variable and ESJS scores		Multivariable models testing associations between all backwards stepwise selected variables and ESJS scores	
	β	95% CI	β	95% CI
Housing situation				
Own	Reference		Reference	
Rent	**−3.64**	**−4.51, −2.77**	**−1.25**	**−2.09, −0.41**
Other	**−3.3**	**−4.94, −1.67**	−1.2	−2.65, 0.25
UCLA loneliness score	**−1.33**	**−1.52, −1.14**	**−0.59**	**−0.78, −0.41**
Self–rated health				
Poor	Reference		Reference	
Fair	**2.09**	**0.53, 3.64**	0.48	−0.91, 1.87
Good	**3.82**	**2.38, 5.26**	0.67	−0.68, 2.02
Very good	**5.54**	**4.06, 7.02**	**1.8**	**0.39, 3.21**
Excellent	**9.42**	**7.63, 11.22**	**3.58**	**1.87, 5.29**
Disability Status				
No	Reference		Reference	
Yes	**−2.83**	**−3.62, −2.04**	−1.13	−1.84, −0.43
Religious affiliation				
Protestant	Reference		Reference	
Catholic/Orthodox	0.82	−0.38, 2.02	0.16	−0.90, 1.21
Non-Christian	**−4.1**	**−5.38, −2.82**	**−4.12**	**−5.28, −2.96**
Agnostic	**−2.55**	**−3.63, −1.47**	**−2.51**	**−3.46, −1.56**
Atheist	**−5.21**	**−6.52, −3.89**	**−4.84**	**−6.00, −3.68**
Other Christian	**3.42**	**2.07, 4.77**	**1.71**	**0.52, 2.91**
Rurality-Urbanity			Not selected	
Urban	Reference			
Rural	0.7	−0.19, 1.58		
Suburban	0.63	−0.46, 1.72		
Region				
Ontario	Reference		Reference	
Atlantic Canada	−0.6	−2.01, 0.81	0.17	−1.04, 1.37
British Columbia	**1.14**	**0.11, 2.18**	0.83	−0.06, 1.71
Prairies	**2.98**	**2.01, 3.94**	**1.58**	**0.75, 2.41**
Quebec	**−3.25**	**−5.08, −1.41**	**−2.62**	**−4.19, −1.05**
Territories	4.72	−0.71, 10.15	2.26	−2.39, 6.91

Bold values indicate $p < 0.05$.

of the status quo; (2) that system-justifying beliefs would be lower among people whose needs were less well-met under the status quo, and (3) that some marginalized groups would nevertheless hold stronger system-justifying beliefs compared to privileged groups due to marginalizing processes that increase the costs and/or reduce the benefits of challenging the system. Results from our study generally supported these hypotheses, as discussed below:

Hypothesis 1: System justifying beliefs are widespread

Examining the first hypothesis, we find that system-justifying beliefs are widespread. For example, when looking at the item response patterns for the ESJS, 8 of the 17 scale items had at least half of respondents support the system-justifying position. Given that Canada's political system

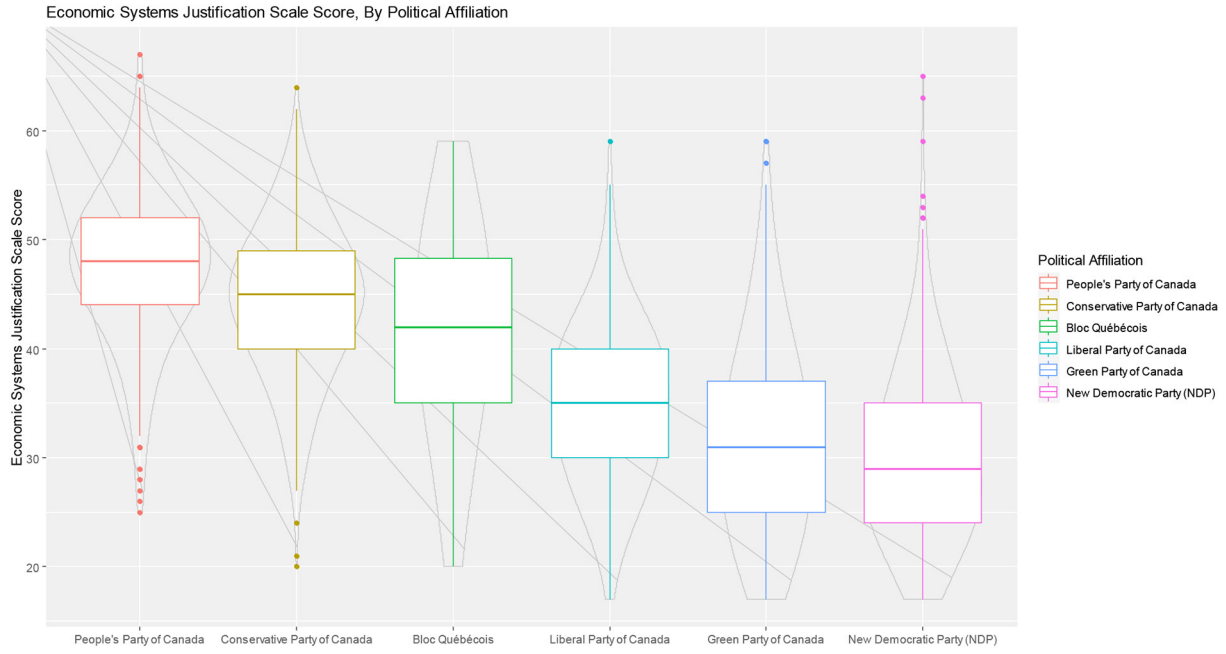

FIGURE 2
Boxplots of ESJS scores, by political party affiliation.

FIGURE 3
System justification scale scores, by income level and self-rated health status.

is a multi-party parliamentary system, this level of support for these items is significant and cuts through political party divides (See Figure 2 for boxplots showing ESJS scores, stratified by political party affiliation). The wide-spread nature of system-justifying beliefs supports the assertion of systems justification theory that people from across all strata and

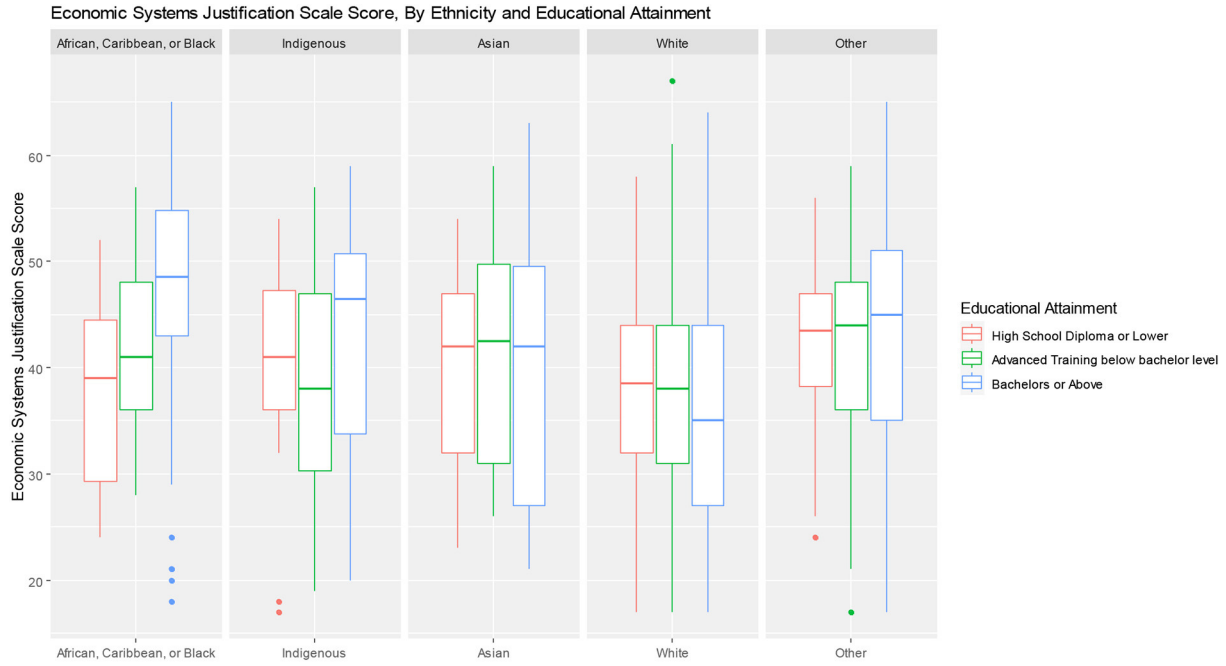

FIGURE 4
System justification scale scores, by ethnicity and educational attainment.

segments of society actively participate in the upholding of established social and economic relations in Canada (11). This finding has major implications for understanding how the bias toward the status quo undermines the advancement of equity-oriented policies that would improve the health and wellbeing of Canadians.

Hypothesis 2: Those benefiting from a system show more support for the system

That said, results regarding our second hypotheses indicated that participants who were less well off in the Canadian system generally had lower ESJS scores—meaning they were less likely to hold system justifying beliefs. Indeed, poorer health, higher loneliness, lower income, and renting instead of owning one's home were all associated with lower propensity to hold system-justifying beliefs. These effects appear to be compounding—as shown in Figure 3, which shows increasing levels of system justification, by health status, within income groups. These findings support System Justification Theory, which predicts people would be benefited by justifying the system (11). Even though the causal pathways are not easily identified in our cross-sectional data, our study does indicate that the relationship between system justification and wellbeing are wide-ranging—affecting multiple life domains. A circular, feedback-loop style of causation is likely implied (i.e., people who hold system justifying beliefs thrive in the system, and this thriving reinforces their system-justifying behavior)—though future longitudinal cross-lagged panel models would be helpful in establishing the presence of this causal pattern (63).

However, it is important to note the instances in which indicators of "success" were associated with less systems-justifying belief. These included higher educational attainment and being a student—factors which may highlight opportunities for the continued and expanded use of public education as a means of overcoming status quo bias (64). However, as shown in Figure 4, we should not necessarily assume that the radicalizing force of education works the same for all identity groups. These data show that while higher education might be associated with lower system justification for white individuals, there appears to be a positive association for African, Caribbean, and Black individuals—perhaps because Black youth who do not behave in accordance with system-justifying beliefs are less likely to be admitted by educational institutions or perhaps those who are recognize and attribute their success to the tremendous efforts required to gain admission and success within the educational system. These associations may highlight the tendencies of some life experiences to either promote or discourage system-justification—and

that the effects may be modified according to one's social position. Understanding differences in these dynamics between demographic groups may be critical for effective messaging that can help individuals to rationalize interventions that would promote health equity. In particular, these dynamics promote the need for community-based and culturally-aware interventions that seek to build community support within key populations.

Furthering underscoring the importance of understanding these nuanced dynamics, our findings regarding occupation showed lower ESJS scores among people working in education, law, health, science, and government, highlighting the ways that potential pressures within one's everyday social environment may inform the emergence of system-justifying or system-challenging beliefs. The role of occupation may be especially important for further research, given the prominent social and political role that some industries can play in shaping Canadian policy and the extent to which cultural deviation within occupational cultures could limit the success of dissenting individuals within these micro-cultures (65–67). Nevertheless, despite these situational factors—and even controlling for them in the multivariable model—our findings generally support the second tenet of our hypothesis, which predicted higher system-justification among more successful individuals and lower system-justification among those who were marginalized by mainstream expectations of health and success. Recognizing how these personal motives drive support or rejection for a system, educators and activists should adopt an empathetic and conversational approach that can help individuals understand how our different life experiences might inform our world views (68). Doing so may help people recognize the value of lived experience in understanding the need for creating systems which help a greater share of the population and therby promote health equity.

Hypothesis 3: Systems rejection is suppressed in some groups for whom costs may be too high

Regarding our third hypothesis, results show that some marginalized groups had higher ESJS scores compared to their relatively less-marginalized comparators. For example, non-binary and non-white individuals (i.e., African, Caribbean, or Black; Arab/West Asian; Indigenous; Other ethnicity) had stronger system-justifying beliefs than men and white people, respectively. However, not all marginalized identity groups had elevated ESJS scores compared to their privileged counterparts. For example, non-Christians had lower ESJS scores than Christians, despite the plurality of Canadians reporting Christian affiliation. Similarly, women had lower ESJS scores compared to men—despite historical and present-day sexism against women. Finally, people living in Quebec also had lower ESJS scores compared to those living in Ontario—despite historical tensions between Quebec and the Federal government.

Each of these findings is worthy of further sociological examination and a number of hypotheses could be advanced to explain these observations. For example, the oppression of gender minority and non-white individuals very likely increases the costs of desisting from system-justifying beliefs as is the case when minority political candidates are judged as more extreme compared to white and male candidates (69)—increasing the social sanctions (costs) for holding "extreme" views. These pressures can give rise to politics of respectability—which are used to deflect social pressures targeting one's identity (70, 71). Indeed, historic legacies of Canadian colonialism, nationalism, patriarchy, racism, and paternalism have sought to create "docile bodies" that conform to and support the Canadian status quo (8, 72–74). If these socialization processes have been able to achieve their goals of oppressing their target groups, this provides one mechanism to understand the phenomenon of higher ESJS scores among historically marginalized groups.

The challenge then is to understand how some groups have successfully overcome these restraints? For example, lower ESJS scores among women—who have certainly been oppressed for thousands of years by patriarchal, man-dominated society—suggests that perhaps the success of the feminist movement may have provided a pattern for eroding system-justifying ideologies. If this is the case, it becomes hard to explain why similarly valiant civil rights efforts have failed to support system-challenging ideologies among racialized people? Perhaps the respectability politics inherent in these movements are a key moderator? (71, 75). Alternatively, the causal paths underlying our observations have less to do with the oppressed groups and more to do with the socializing processes of their comparators. For example, white people may have low ESJS scores because they are more privileged in the Canadian system to dissent, and men may have higher ESJS scores than women because the contemporary system has more effectively brought men under the control of contemporary systems of patriarchy and masculinity (76). Given the complexity of the relationships identified here, these separate phenomena must be examined further on a case-by-case basis. It is, of course, possible—or even likely—that social processes not considered here (e.g., social dominance, group identity) override the standard effects to create these unique cases. As such, further qualitative and quantitative research on system justifying beliefs is merited.

Limitations

The present exploratory study has several limitations that can be addressed in follow-up research. This study relies on a convenience online sample and a cross-sectional survey design. Findings may therefore not be generalizable or representative. Our sample skews older than the Canadian population, which may be an artifact of the sampling procedures and self-selection—as well as our restriction to adults age 16 years or older. All findings thus require replication and collaboration through other studies and approaches (e.g., telephone surveys, in-person sampling). We also note that our questionnaire was limited in scope. A variety of other social processes could be explored as confounders, mediators, and moderators to explain the associations we analyzed. Analytically, our regression models have identified the independent and adjusted factors associated with system justification, but future analyses could adopt an intersectional approach (e.g., How does system justification relate to the monolithic cis-white-straight-male identity?) to better understand potential group dynamics that drive system-justification.

Conclusion

Regardless of our study's limitations, our findings advance the literature on System Justification Theory and the status-legitimacy hypothesis and demonstrate the operationalization of gender, ethnicity, and other markers of social position in shaping system-justifying ideologies of people in Canada. Furthermore, we conclude with support for a proposed three-part hypothesis that advances the idea that system-justifying beliefs are widespread, that adverse life experiences degrade system justifying beliefs, and that this effect is moderated within key identity groups—perhaps by the force of oppression exerted upon these groups. While further evidence is needed, several lines of inquiry related to the role of social identity and historic oppression are opened to understand how and why some demographic and social identities lend themselves to support of the existing system and status quo. Advancing the cause of health equity will require changes to the Canadian system, and our research will hopefully help us to understand how to manage ideologies that are biased in favor of the status quo.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Harmonized Research Ethics Board of British Columbia. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

KC conceptualized the design of the study and undertook analyses. KH assisted with the interpretation of study results and writing of the final manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Accelerating systems thinking in health: Perspectives from the region of the Americas

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Introduction: The Systems Thinking Accelerator (SYSTAC) is a community to engage, connect and collaborate to elevate the field of systems thinking with a focus on low- and middle-income countries, highlighting the need to identify existing capacities within research and at the practice level. The study aimed to explore if there is a perceived need for and benefit from the application of Systems Thinking tools for analysis and diagnosis of problem-solving within Healthcare in the Region of the Americas in 2021 and the existing capabilities.

Methods: The identification and deconstruction of the needs, demands, and opportunities regarding systems thinking in the Americas were approached by: (i) adapting the tools and Systems Thinking definition to reflect regional nuances, (ii) identifying stakeholder exercise, (iii) needs assessment survey distribution, (iv) stakeholder mapping analysis, (v) workshop. More information on the adaptation and execution of each tool can be found below.

Results: 123 stakeholders were identified, of which 40 participated in the needs assessment survey. 72% of respondents indicated little knowledge of the tools and approaches of systems thinking but a high interest in developing them, as stated by 87% of respondents. Qualitative tools were most frequently used, such as brainstorming, problem trees, and stakeholder mapping. Systems thinking is mainly used when conducting research, implementing, and evaluating projects. A clear need and want for training and developing capacities in health systems thinking were identified. However, in practice, systems thinking faces challenges like resistance to change and to the transformation of health processes, barriers at the institutional level, and other administrative disincentives that hinder its application, being institutional transparency, political will, and the articulation of the actors the main challenges.

Discussion: Strengthening and building personal and institutional capacities in systems thinking theory and practice requires overcoming challenges such as lack of transparency and inter-institutional cooperation, the low political will to implement it, and difficult stakeholders' integration. As a first step, it is crucial to understand further the stakeholder network and the capacity needs of the region, gain buy-in from strategic players to establish the use of system thinking as a priority, and develop a roadmap.

KEYWORDS

systems thinking, stakeholder mapping, health system, Region of the Americas, SYSTAC, community building

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1. Introduction: Systems thinking in the Region of the Americas

The Systems Thinking Accelerator (SYSTAC) defines Systems Thinking as an approach to problem-solving that views problems as part of a wider dynamic system and therefore requires a deeper understanding of the behavior of complex adaptive systems in designing, evaluating, and implementing health policies to maximize health and health equity (1). It recognizes and prioritizes the understanding of linkages, relationships, interactions, and interdependencies among the components of a system that give rise to the system's observed behavior. Systems thinking is a philosophical frame, and it can also be considered a method with its own tools (2). Systems thinking can be used in research, policy, or practice.

Since the publication of the Alliance for Health Policy and Systems Research (the Alliance) flagship report "Systems Thinking for Health Systems Strengthening," systems thinking in health policy and systems research (HPSR) has been widely accepted. However, it has become apparent in recent years that systems thinking in HPSR has largely remained (i) the purview of researchers, and (ii) perceived as primarily conceptual, with limited examples of applications of systems thinking available—particularly in policymaking and practice, and especially in low- and middle-income settings (LMICs).

For this reason, the Alliance is developing the Systems Thinking Accelerator (SYSTAC) initiative, a community for systems thinkers to engage, connect and collaborate, to elevate the field of systems thinking to improve health. The Alliance is launching the SYSTAC as a global community-of-practice, with a focus on practitioners in health systems in LMICs.

A core component of SYSTAC will be to bring together a diverse group of stakeholders that goes beyond academia and research to include practitioners and decision makers. It aims to be an ecosystem of partners working to advance health. The high fragmentation of health systems in LMICs (3) forces stakeholders to work in silos with very limited integration of the different components of the health system, thus constraining their ability to adopt multi-sectoral approaches. SYSTAC aims to increase the critical mass of systems thinkers and connect those who have been working in isolation. Although SYSTAC focuses on systems thinking within the health sector, actors and expertise in systems thinking from other sectors will be welcomed to contribute and improve systems thinking approaches for health.

As part of the process to build and create a community and platform for the Region of the Americas, a road map was developed and the research team was contacted to bring together different actors from the Region of the Americas (decision makers, researchers, professionals in the field), aiming to strengthening Systems Thinking capacities and its application in Health Systems in the region, and connect them with other regional institutions. The research team is an interdisciplinary team in Costa Rica with expertise in public health and health systems research in Costa Rica and in the Region of the Americas.

As a first step for developing the SYSTAC-Region of the Americas community an initial needs assessment has been carried out, identifying the key needs, capabilities, demands and opportunities for the application of Systems Thinking in Healthcare in the Region of the Americas.

Countries in this region share many economic, political, social, and cultural similarities but at the same time vary among themselves, with diverse Health Systems and capabilities. The Region of the Americas is one of the regions with the lowest investment in public health, additionally historical characteristics of the health systems in the region have complicated effective responses to challenges in health (3).

These challenges are due in part to a fragmentation and segmentation of medical services (3) based on the poor from the formal sector, resulting in significant gaps in health care access and quality for this group. Within the formal sector, the private sector varies in extension and importance within the region, but mainly requires people to have insurance or pay-for-service. The public sector in Region of the Americas countries instead is divided into two health systems segments: a relatively well funded social security for salaried workers and their families and a Ministry of Health system serving poor and vulnerable people with low standards of quality, except for Costa Rica (4).

This fragmentation in the health system and service delivery, together with the poorly regulated private sector, becomes a challenge for efficient services. Health care performance and quality of health service delivery is also weak, with poor primary health care systems and limitations in advance hospital services, with little progress in the past years in several countries. Decentralization of funding and decision making is another common issue to the Region of the Americas. This is a process that has developed to respond to the need of promoting development in the regions and provinces within the countries. However, especially related with public health and health systems, it has generated more complicated environments for governance, different levels of wealth in the regions, differences in performance, priorities, and capacities to respond to health issues and even politicization of health decisions (4).

Taking the above into consideration, and the current health crisis due to the COVID-19 pandemic (5), it is vitally important to identify and strengthen regional health capacities in the Region of the Americas by leveraging Systems Thinking capabilities and tools, both for their application at the scientific and practice level. The focus on health by SYSTAC, rather than the "health sector," means that it aims to reflect the reality of health, which is complex, necessitating a multi-sectoral, regional lens, and interdisciplinary collaboration for improving health.

For this reason, the goal of this research study was to explore if there is a perceived need for and benefit from the application of System Thinking, within healthcare, in the Americas Region, in the year 2021, by decision makers, researchers, and professionals in the field. As well as investigate what the existing System Thinking capabilities are within the region and field. Next steps, after this initial assessment, will include an effort to build a SYSTAC-Region of the Americas community that brings together the different key stakeholders needed to strengthen regional capacities for the application of Systems Thinking at the regions' Health Systems.

2. Methods

To explore the perceived needs and demands of systems thinking practitioners, researchers, managers, and decision makers in the field of healthcare in the Region of the Americas, as well as the current capabilities the following approach was undertaken:

1. Map and catalog existing and potential actors and initiatives in the Region of the Americas and further identify actors to join SYSTAC.
2. Survey the needs and demands of systems thinking practitioners, researchers, managers, and decision makers in the field of healthcare in the Region of the Americas, in order to inform a roadmap to improve the capacity to apply systems thinking in health in the region.
3. Document the key barriers and opportunities for applying systems thinking in healthcare in the Region of the Americas.

For the fulfillment of the above the first step was to identify an initial list of stakeholders to contact for participation in the needs assessment and to adapt the SYSTAC needs assessment tools to the local context and language. This included the adaptation of SYSTAC's definition of Systems Thinking to regional nuances and context. In addition, the tools/techniques adapted were: i. a needs assessment survey, ii. stakeholder prioritization exercise, iii. workshop. More information on the adaptation and execution of each of these tools can be found below. Firstly, the needs assessment survey was conducted reaching out to a wide set of stakeholders. The survey findings were used to inform the stakeholder prioritization and to plan the workshop. Findings from the survey, stakeholder prioritization and workshop were integrated as a product of the study.

2.1. Stakeholder identification

A stakeholder identification brainstorming session was conducted by the research team to identify actors according to the role of decision makers, health practitioners, providers, health professionals, and researchers. Decision makers are those who are most responsible for developing policies and/or making funding decisions, such as global and national policy makers and funders. Researchers are those who study a phenomenon, but are not per se involved in delivery, implementation, or decision making around that phenomenon. Health professionals are those who are engaged in service delivery and/or implementing policies, health promoters and educators. Health practitioners are healthcare providers who are directly engaged with the provision of medical care. The list of identified stakeholders was further developed to contain (i) sector, (ii) institution, and (iii) regional scope of each stakeholder. In addition, stakeholders were listed from different sectors in health such as academia, NGOs, independent providers, private and public sector. This initial stakeholder list was created mainly based on existing work networks, and identification of regional institutions linked to the research team.

2.2. Needs assessment survey

A needs assessment survey was developed and deployed to stakeholders identified above to gain insights on the regional capabilities, needs and interests regarding Systems Thinking.

As a first step the survey and an introduction note on SYSTAC/invitation to participate in the survey were created. The note and survey were developed collaboratively by the research team through a series of internal working sessions in which both were created, refined, and approved. The note and survey were shared with the regional stakeholders identified by the research team *via* email, and they were given 2 weeks to complete the survey. During this time, they were contacted once again directly by phone or email as a reminder.

The survey was developed using google forms and structured in three segments: (a) an initial segment to gather general information on the participants such as contact information, demographic, and occupational information, (b) a second segment to gather data on participants' knowledge and interest regarding systems thinking, its application and tools to inform the stakeholder mapping and prioritization exercise found in the next subsection. Additionally, this segment explored the challenges and opportunities faced when implementing systems thinking in the Region of the Americas, and (c) a final segment to document resources, initiatives and additional systems thinking stakeholders found in the region. The survey included both close-ended and open-ended questions, it contained a total of 23 questions (21 multiple questions, and 7 open-ended questions).

A descriptive statistical analysis, conducted in excel, was undertaken to analyze the data gathered in the survey and leverage it for the creation of the workshop.

2.3. Stakeholder mapping and prioritization

A description, prioritization, and classification of the survey stakeholders was conducted. Validating the following categories: sector, institution, regional scope; and then according to their levels of interest and Systems Thinking knowledge. The level of knowledge and initial opinion about applied systems thinking, their needs, demands, and capacities were identified through the needs assessment survey. Additionally, their acting role as decision-makers, practitioners, managers, and/or researchers was identified.

The stakeholder mapping exercise was conducted leveraging thereafter and aimed to refine and expand the information gathered during the initial consultation, with the main objective of guiding and the design of the SYSTAC-Region of the Americas community while ensuring SYSTAC fulfills a relevant role in the existing regional ecosystems and with the intent that no key stakeholder is forgone. Having said this, the process of identifying all key stakeholders is ongoing and does not conclude with this study. Gathering this information allowed the team to have a clearer overview of the regional actors with awareness/interest in systems thinking in the region, the relationships between stakeholders, the needs and demands for applied systems thinking, and how these can be strengthened to inform how SYSTAC will build on or

TABLE 1 Categories for mapping of stakeholders according to their knowledge of and interest in systems thinking.

Target Audience	Definition
High knowledge/high interest	Those who are more wellversed and knowledgeable of systems thinking tools and approaches and are interested in participating in a community
Low knowledge/high interest (I)	Those who are not aware of system thinking and wish to learn about the topic, they may have minimal knowledge or could be applying systems thinking approaches or methods without knowing it
High knowledge/Low interest (II)	Those who are more wellversed and knowledgeable of systems thinking tools and approaches but are not interested in participating in a community
Low knowledge/Low interest	Those who are not engaged in systems thinking and not interested in developing system thinking knowledge

complement other regional activities; and plan how the regional activities will engage with the different stakeholders.

To identify the level of knowledge/interest in systems thinking of the stakeholders, the matrix "Categories for the mapping of stakeholders according to their knowledge and interest in Systems Thinking" provided by SYSTAC Central was used and adapted (Table 1).

2.4. Workshop

To explore the needs, barriers, and opportunities for accelerating the application of systems thinking in health in the region, and linked to the stakeholder mapping conducted, the 123 stakeholders identified initially were convened to participate in the workshop entitled ***"Accelerating Systems Thinking in Health in the Region of the Americas."*** The workshop was held on May 27, 2021, in virtual mode through *Zoom.us* tool, using a theoretical-practical methodology based on dialogue and participation for the collective construction of knowledge, and led by the research team.

For its realization, methodologically two stages were proposed: preparation and execution.

In the Preparation Stage, there were five phases: (a) Analysis of three local successful experiences in health from a people-centered perspective and with intersectoral participation, that reflected the application of systems thinking and its tools, even though they were not strategies designed within the framework of this approach. (b) Selection of one of the successful experiences and elaboration of a case study: *"Conceptual and practical application of the Systems Thinking approach and its tools in a health initiative: Breast Cancer Patient Navigation Project in Costa Rica"* (see Supplemental material), (c) Review of the conceptual elements of Systems Thinking in Health and its tools, applied in the successful experiences identified, and how this led to change; and (d) Joint construction of a methodological proposal for the workshop that included the activities to be carried out, materials, time, and selection of facilitators within the research team, which was presented, discussed, adapted and validated in 4 working sessions of the team of researchers.

The Execution Stage was developed in four blocks: welcome, framing, workshop development through the analysis of the case study, and final reflections. The welcome activity included a presentation of the research central team and participants, followed by a contextualization of the initiative, the reason for the call and the objective of the workshop. This was followed by a discussion and validation, with the workshop participants, of the adapted definition of Systems Thinking in health proposed by the research team and applied to the Region of the Americas.

During the workshop, the analysis of the case study was carried out through an exercise in four subgroups, each one facilitated by a representative of the SYSTAC- Region of the Americas research team with the support of questions to generate dialogue. Finally, in the plenary session, each person facilitating the subgroups presented the main discussions and group dialogue to the audience. For the activity corresponding to the last block "Final Reflections," a dynamic with the *Padlet.com* tool was proposed to individually share ideas about possible training opportunities, how to strengthen systems thinkers' networks, new linking actors and ideas to outline a regional acting route. These topics will be considered an essential starting point in the continuity of the process toward the Systems Thinkers community building as they will help to address the priorities in the region.

3. Results

To have a conceptual starting point, the definition provided by SYSTAC about systems thinking was used as a reference for the research team, translated to Spanish and adapted with a local lens to the region. The definition of Systems thinking proposed by the SYSTAC-Region of the Americas team, which was validated with the stakeholders during the workshop is as follows:

> "A needs-solving approach that views problems as part of a larger, interdependent dynamic system and therefore requires deeper understanding. It is about understanding open systems, with adaptive, resilient, and complex behaviors, in which health policies are designed, evaluated and implemented to maximize health and equity. Recognizes and prioritizes the understanding of the links, relationships and interactions between the different components that make up the system. This is a conceptual and practical approach that, in turn, considers various methods with their own tools. Systems thinking can be used in research, policy or practice."

3.1. Stakeholder identification

During the stakeholder identification brainstorming section 123 stakeholders were identified and later invited to participate in the study. Stakeholders corresponded to decision makers, health practitioners, health professionals and/or researchers within the Health System. The amount was identified by the research team as: 31 were decision-makers, 13 practitioners and 21 researchers, and 72 health professionals who develop various actions associated

TABLE 2 Characterization of the stakeholders participating in the needs assessment survey.

Category	*n* (%)
Age	
<25 years	1 (3%)
26 to 35 years	7 (18%)
36 to 45 years	10 (25%)
46 to 55 years	10 (25%)
56 to 65 years	6 (15%)
>65 years	6 (15%)
Gender	
Female	21 (53%)
Male	19 (48%)
Respondent's classification	
Management	18 (45%)
Researchers	13 (33%)
Decision makers	5 (13%)
Practitioners	4 (10%)
Geographical reach of their work	
Global to community	1 (3%)
Global	5 (13%)
Regional	9 (23%)
Country	24 (60%)
District	1 (3%)
Community	0 (0%)

with health services. This list contained a preponderance of action at the national level and only 4 actors with a regional scope. The list included stakeholders in the age range of 25 to 75 years old. Finally, identified stakeholders came from universities, NGOs, hospitals, private and public health sector.

3.2. Needs assessment survey

From the 123 identified stakeholder invited to participate in the survey 40 answers were received, corresponding to a response rate of 34%. Respondents came from all four communities of interest highlighted by the research team. The 60% of the respondents worked at the country level, 23% of respondents worked at the regional level and 16% of respondents worked at the global level but were based out of the Region of the Americas, while only 3% of the respondents worked at the district or local level. Respondents worked mainly in Costa Rica and across different countries in America, some of the countries which their work impacts are Canada, USA, Mexico, Salvador, Guatemala, Honduras, Nicaragua, Costa Rica, Haiti, Cuba, and Ecuador (Table 2).

A 75% of the participants reported having used systems thinking, 12.5% are not sure and 12.5% reported not having used this methodology before. The 12.5% of respondents who have not used Systems Thinking before were asked to skip to the last two questions of the survey to gage their interest in learning more about Systems Thinking, for this reason the denominator used for the following percentages is 35. Of the 35 respondents that have used or may have used systems thinking previously, 68.6% reported having used systems thinking tools and 31.4% are not sure that they have used the tools. Having said this, when the 35 participants were asked to select from a list of systems thinking tools (e.g., problem tree, process mapping, brainstorming, network analysis, etc.) that they have used, all of them selected one or more tools. The tools most frequently used were qualitative tools such as brainstorming, used by 83% of the respondents, problem trees used by 80% and stakeholder mapping used by 74% (Figure 1). A 69% of survey participants use Systems Thinking when conducting research, 57% when implementing projects and 49% when evaluating projects, as seen in Figure 2.

More than half of the participants reported having had some challenges when implementing Systems Thinking. The main challenges of implementing systems thinking are related to time, resources, and knowledge (Figure 3).

Finally, the main benefits of applying systems thinking reported in the survey were in the articulation of a problem or need, helping with decision taking, and during coordination.

In addition, through the survey, 4 systems thinking groups/initiatives, 14 health strengthening initiatives, 7 programs/courses/trainings, 7 additional key stakeholders, and 5 publications in the Region of the Americas were identified.

3.3. Stakeholder mapping and prioritization

The survey participants were classified and mapped according to their levels of interest and knowledge regarding systems thinking, as shown in Figure 4.

A 61.53% of participants described a low knowledge in systems thinking but high interest in developing capabilities and joining a community of interest. The 25.64% described both a high interest and high knowledge in the topic. Both this groups were identified as key segments, the first as individuals who will benefit from joining SYSTAC to gain capabilities in Systems Thinking. The second as key participators, instrumental in enhancing and sharing their experience regarding Systems Thinking in the region with the other stakeholders. Finally, the 2.56% of participants with high knowledge but low interest were classified as stakeholders to keep satisfied as they are influential in the field although minimally engaged (Figure 4).

In this stakeholder mapping exercise, it was not possible to identify the relationships between actors, their interests, and resources to understand linkages, relationships, interactions, and interdependencies among the components of a system that give rise to the observed behavior. Part of the differences for this detection is the need to have scopes by countries that allow more knowledge of local dynamics and realities to move toward a regional perspective according to levels of interest and influence in the global community of systems thinkers. Additionally, of the participating stakeholders 45% classified themselves as Managers, 33% as Researchers, 13% as Decision Makers and 10% as Practitioners. These categories were not mutually exclusive

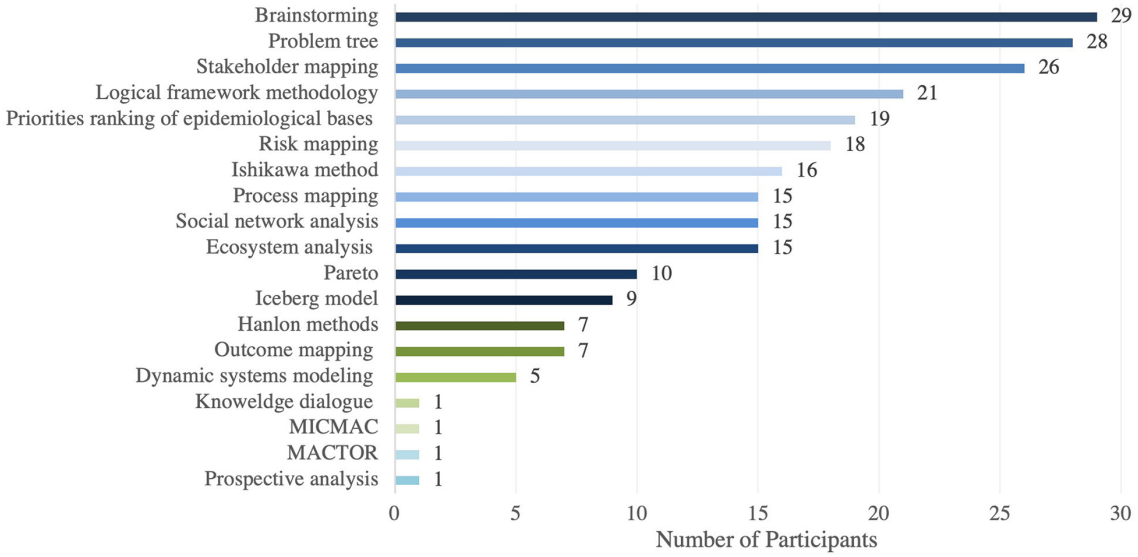

FIGURE 1
Stakeholders most commonly use systems thinking tools in the needs assessment survey.

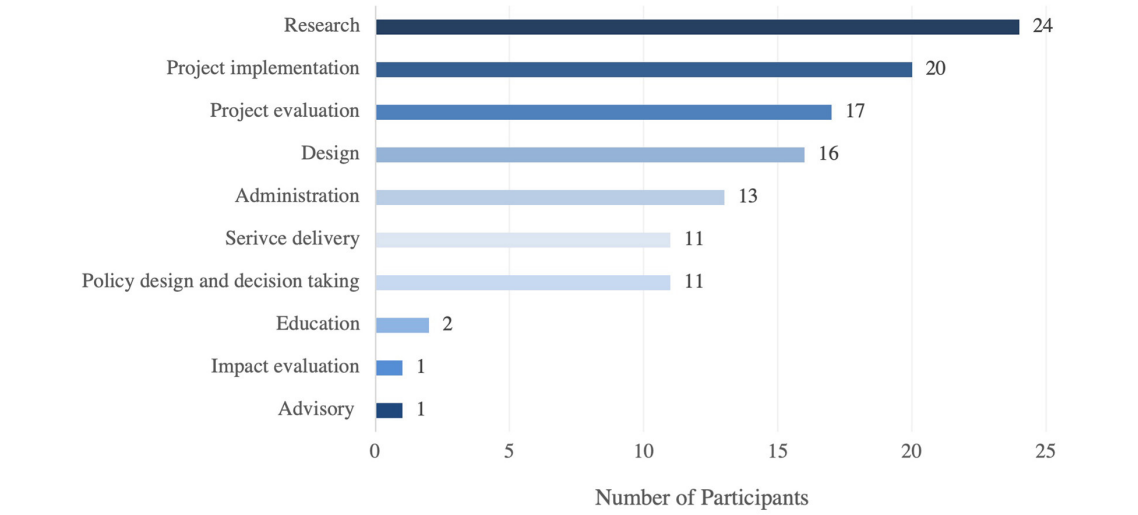

FIGURE 2
Scenarios with experience in the use of systems thinking tools.

because people are not one-dimensional. Most of the stakeholder's when self-classifying identified themselves in the three categories. This added complexity to the mapping and classifying of their actions, application according to its role of systems thinking, and determination off significant relationships with other actors and stakeholders. For this reason, and due to a small sample size of participants in the survey we recognize that further work is needed to better understand the stakeholder Systems Thinking network in the region.

3.4. Workshop

The workshop was held on May 27 of 2021, 23 stakeholders participated, including the research team. There were representatives of multilateral organizations such as the Pan American Health Organization, institutions such as the Ministry of Health, and the Costa Rican Social Security Fund, local and regional academic institutions (universities and research centers), non-governmental organizations and the private sector. This allowed contributions to be made from different levels of operation, locally, regionally, and globally.

As mentioned above, the Systems Thinking in health definition outlined at the beginning of the results section was expanded on and validated with the workshop participants. Collective discussion and reflection through the case analysis made it possible to identify that the application of systems thinking in health interventions requires an approach focused on individuals, families, and communities, which recognizes and reduces the distance between the elements that make up the Health System

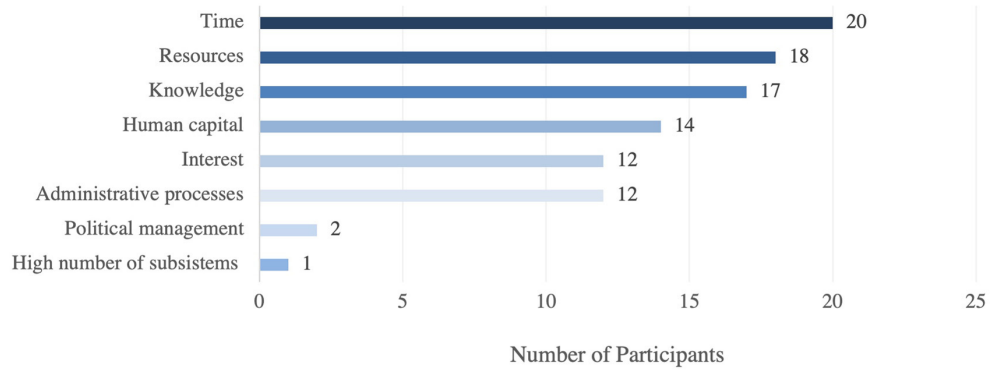

FIGURE 3
Main challenges in implementing systems thinking in the Region of the Americas.

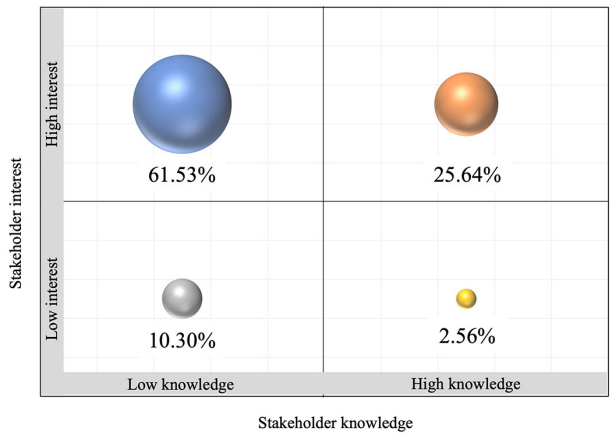

FIGURE 4
Levels of interest and knowledge about systems thinking among the participants in the survey.

and incorporates cultural and gender diversity, while at the same time harmonizing with other complex approaches such as Social Determinants and Health in All Policies.

Systems Thinking was conceived in the workshop as an approach that recognizes both organizational and civil society capacities, with multidisciplinary and inter-institutional cooperation being essential for strengthening teamwork. In addition, it was identified that continuous training for the development of capacities in the application of systems thinking in health implies continuous training processes that favor the application of its tools. Participants mentioned that it should be built from the bottom up with the active participation of civil society in the different stages, from design and planning to implementation, monitoring, and evaluation.

Despite the above, in practice, participants identified that systems thinking in the region faces different challenges, such as resistance to change and to the transformation of health processes. It was highlighted that barriers at the institutional level and different administrative disincentives hinder its application. Furthermore, institutional transparency, political will, and the articulation of the actors, are key to the successful application of Systems Thinking in health in the region.

It was identified that applying Systems Thinking brings different opportunities when designing, planning, executing, monitoring and/or evaluating health initiatives in the Region of the Americas, as it allows democratic and horizontal structures, while favoring empowerment for participation, integration, and synergy of all components of the Health System, continuous information flows and evidence generation. Thus, by conceiving health as a multidimensional and multifactorial element, the application of systems thinking allows the analysis and evaluation of all its dimensions, facilitating the integration between public and private sectors, integrating social, economic, and political aspects which in turn allow the expansion of perceptions and health scenarios.

4. Discussion

The main takeaways from the needs assessment survey, stakeholder mapping and prioritization, and the workshop were integrated to better understand the challenges and opportunities to accelerate Systems Thinking within the region. These integrated findings are presented in Figure 5 and discussed below.

4.1. Do the capabilities and interest to apply Systems Thinking in the Region of the Americas exist?

Participants show great interest in developing and applying the tools of systems thinking, although they report little theoretical knowledge in this regard. This research identified that only 28% of participants reported a high knowledge of the tools and approaches of system thinking, although 87% reported a high interest in developing skills related to Systems Thinking and its application in health. Having said this, stakeholders may already use Systems Thinking tools in their day-to-day jobs without identifying it as such. Although 31.4% of survey participants reported not having used Systems Thinking tools, all these same participants later selected one or more tools from a list, as tools that they use when preforming their work. These findings highlight that there is an interest in Systems Thinking, and an opportunity to build recognition and capabilities around this methodology. Furthermore, the research team believes that developing these

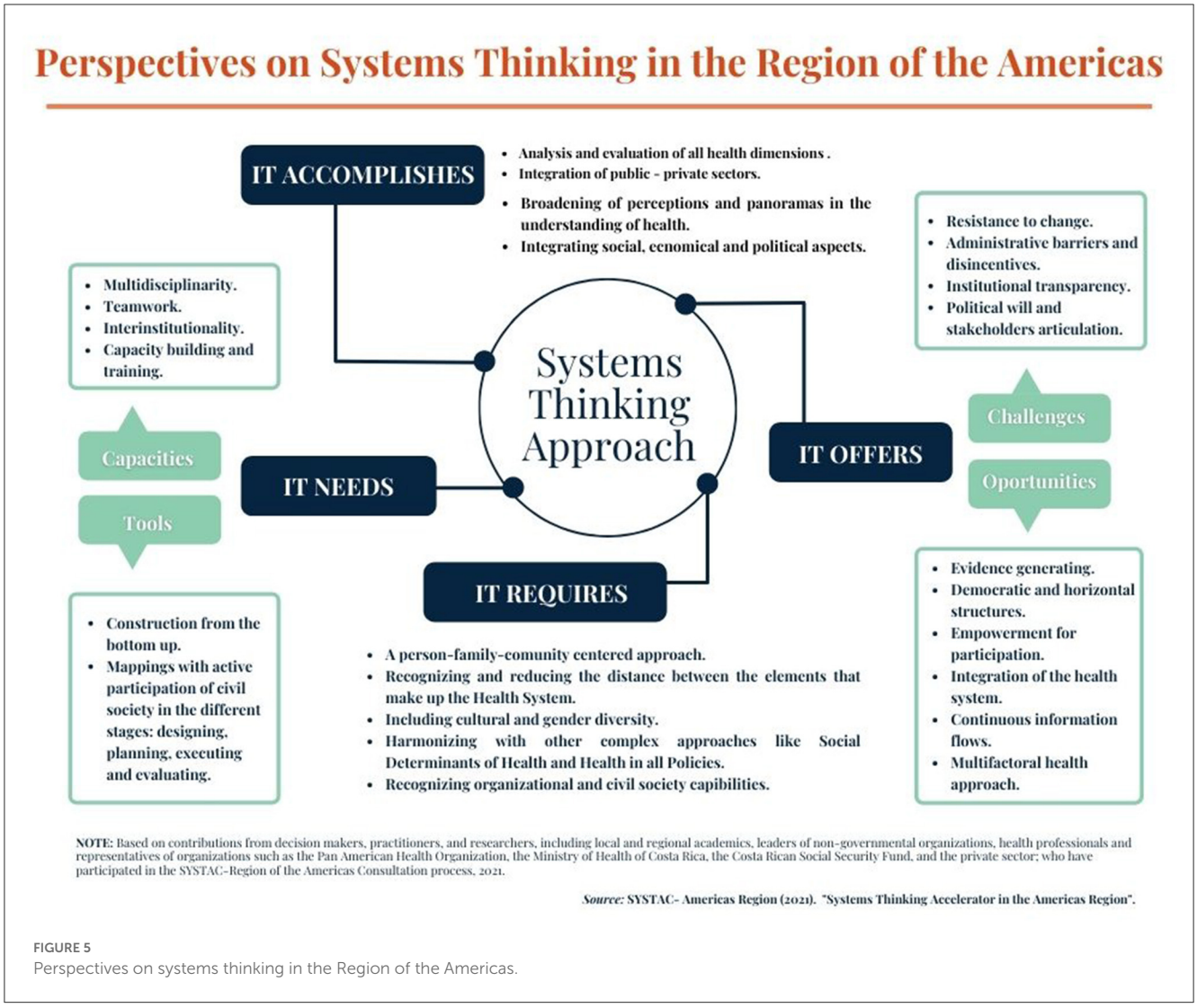

FIGURE 5
Perspectives on systems thinking in the Region of the Americas.

skills and capabilities through a community such as SYSTAC would have a positive impact in the Health Sector in the Region of the Americas within research, project implementation, project evaluation and design.

4.2. What are the main challenges and opportunities to applying systems thinking, in health, in the region of the Americas?

In practice, participants identified that applying system thinking faces different challenges, such as:

- Resistance to change and to the transformation of health processes.
- Barriers at the institutional level and different administrative disincentives such as lack of transparency and inter and intra-institutional collaboration.
- Difficult stakeholder integration.
- Low political will to implement systems thinking due to time constraints,
- Lack of resources and lack of funding.
- Gaps in knowledge.

Some of which (e.g., access to resources, training to develop capabilities, reducing resistance to change through education, etc.), could be alleviated, or minimized through initiatives such as SYSTAC. Furthermore, a Systems Thinking community could help build political will and be instrumental in the articulation of the actors, which are key to the successful application of Systems Thinking, in health, in the region. Additionally, such a community represents a valuable learning and knowledge exchange opportunity for systems thinkers.

Although survey participants described using Systems Thinking during research, more than half also mentioned using it in practice, when implementing and evaluating projects, which hints that the use of Systems Thinking goes beyond the purview of research. Additionally, study results indicate that there is a clear benefit to strengthening and building personal and institutional capacities in systems thinking theory and practice, in the region. During the discussion and reflection of the case analysis in the workshop, it was identified that the application of systems

thinking in health interventions helps frame the interventions from additional perspectives to the providers' perspective, such as that offered by the individuals/patients, families, and communities, integrating cultural and gender diversity, which in turn can have a positive impact on the health system. Furthermore, systems thinking was described as a multidisciplinary and inter-institutional approach which strengthens teamwork, is instrumental for gathering evidence, creating democratic and horizontal structures, empowers the different stakeholders and sectors in health systems to participate and collaborate, and promotes a continuous flow of information.

4.3. Proposed next steps for the acceleration of systems thinking in health in the region of the Americas

As a result of the challenges and opportunities, the research team identified the importance of designing and prioritizing a consensual course of action or roadmap for the acceleration of system thinking in health in the Region of the Americas through a SYSTAC community. This interest community should be built from the bottom up with the active participation of civil society in the different stages, from design and planning to implementation, monitoring, and evaluation.

As a first step, it is necessary to expand the call to include a larger number of stakeholders, decision-makers, practitioners, and researchers in the region. Although the process identified a high level of interest in learning about systems thinking and its tools, the number of stakeholders who responded was limited, in part due to the COVID pandemic taking place at the same time as the study. In addition, expanding the type of stakeholders involved would promote inclusivity and ownership, furthering the goal of building System Thinking capabilities in the region. This recommendation will be a priority starting point in the continuity of the process toward community building. Furthermore, it is also necessary to expand the study to cover the multiplicity of tools within System Thinking such as those related to change theory, among many others.

Moreover, further analysis is required to (a) document/describe systems thinkers' networks to be able to strengthen them by linking key stakeholders (existing and new) and ideas, and (b) build a more in-depth understanding of the capacity needs (e.g., such as a more comprehensive understanding of the existing capabilities for the multiplicity of System Thinking tools not only the ones explored in this study) for which training opportunities are required.

Some initial thoughts on possible initiatives toward capacity building are:

- Creating a platform that allows to disseminate existing information and resources on systems thinking, providing access to a repository of resources from which to learn about the main elements and tools of systems thinking.
- Promoting continuous education, and apply a train-the-trainer strategy, by training educators who work in public health schools and other schools which prepare stakeholders who then go into the health system, so that they pass on the knowledge to their students.
- As there are currently some training resources on systems thinking in health in the region, an effort to make them accessible to practitioners, managers, researchers, and decision-makers, should be undertaken.

Having the support of SYSTAC and partner organizations in the different regions in the development and implementation of these initiatives would allow the leveraging of solid and existing structures as a reference point, which would be instrumental in the acceleration of the application of systems thinking in the region.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2023.968357/full#supplementary-material

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Systems thinking in practice when implementing a national policy program for the improvement of women's healthcare

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Introduction: Interest in applying systems thinking (ST) in public health and healthcare improvement has increased in the past decade, but its practical use is still unclear. ST has been found useful in addressing the complexity and dynamics of organizations and welfare systems during periods of change. Exploring how ST is used in practice in national policy programs addressing complex and ill-structured problems can increase the knowledge of the use and eventually the usefulness of ST during complex changes. In ST, a multi-level approach is suggested to coordinate interventions over individual, organizational, and community levels, but most attempts to operationalize ST focus on the individual level. This study aimed to investigate how ST is expressed in policy programs addressing wicked problems and describe the specific action strategies used in practice in a national program in Sweden, using a new conceptual framework comprising ST principles on the organizational level as an analytical tool. The program addresses several challenges and aims to achieve systems change within women's healthcare.

Methods: The case study used a rich set of qualitative, longitudinal data on individual, group, and organizational levels, collected during the implementation of the program. Deductive content analysis provided narrative descriptions of how the ST principles were expressed in actions, based on interviews, observations, and archival data.

Results: The results showed that the program management team used various strategies and activities corresponding to organizational level ST. The team convened numerous types of actors and used collaborative approaches and many different information sources in striving to create a joint and holistic understanding of the program and its context. Visualization tools and adaptive approaches were used to support regional contact persons and staff in their development work. Efforts were made to identify high-leverage solutions to problems influencing the quality and coordination of care before, during, and after childbirth, solutions adaptable to regional conditions.

Discussion/conclusions: The organizational level ST framework was useful for identifying ST in practice in the policy program, but to increase further understanding of how ST is applied within policy programs, we suggest a multi-dimensional model to identify ST on several levels.

KEYWORDS

systems thinking, healthcare improvement, policy implementation, public health, healthcare services

1. Introduction

Many public health and social issues are complex and so are the interventions that can affect them. Such multi-dimensional issues often represent 'wicked problems', i.e., problems that involve multiple sectors, multiple organizational levels, and many actors, and that are dynamic and difficult to define (1–4). This complexity makes it difficult to implement, evaluate, and scale up health interventions (5). How wicked problems should be addressed has been debated as most of the ill-structured and wicked problems defy solutions (6, 7). Usually, they are addressed as if they could be solved, or by reducing them into well-structured problems to control them. An alternative could be to use a coping strategy that focuses on the process of repeatedly trying to resolve the wicked problem (8). Soft-law initiatives, i.e., non-legislative modes of policymaking based on voluntary cooperation, have been a way to deal with such complex policy problems, especially in the Nordic countries (9). However, the focus on the process, the aim to incorporate multiple and competing perspectives on the problem, and the continuously changing contextual conditions make it difficult to lead such soft-law initiatives.

An approach based on systems thinking (ST) can be useful for tackling complex issues when leading soft-law initiatives (2, 10). ST has also been suggested as an aid when identifying high-leverage solutions that can improve multiple health outcomes (11). The interest in applying ST in public health and healthcare improvement has increased in the past decade (12–14). Even so, relatively few applied studies focus on ST within public health, and more research is needed to understand how ST is used in this field (15–17).

Systems thinking is a theoretical approach found to be useful in addressing the complexity and dynamics of organizations and welfare systems when trying to change a current situation (2, 10, 11, 13, 18). ST has multiple origins from diverse scientific traditions, and it involves a wide range of terminologies, theories, and tools (10). Unlike reductionist approaches, ST considers the complexity of a phenomenon and its context, e.g., that interventions are interdependent on each other and on the environment (19–21). A recent review shows that most articles published on ST are conceptual (17). Thus, there is a need for more knowledge about how ST can be put into action within public health and healthcare improvement (18), and the need for further studies and development of practical applications is highly relevant (10, 17).

There are challenges in studying how ST is manifested in practice. At the same time, identifying how ST can be expressed in actions and strategies is an important step in building knowledge about the practical application of ST in public health (22) and the mechanisms behind the effects of quality improvement initiatives (23). ST emphasized the coordination of interventions across multiple levels of change, e.g., individual, organizational, and community levels (24). This "multi-level" approach is in line with what is needed when national policy programs address ill-structured or wicked problems in public health and healthcare.

Most attempts to operationalize and measure ST focus on the *individual level* relating ST to individuals' understandings, abilities, skills, and cognitive processes. Studies on ST emphasize individuals' knowledge and abilities, for example, to be able to understand how the system is organized, managed, and led; to understand and be able to manage system stakeholders and networks; and to have the ability to conceptualize, model, and understand dynamic change (24–26) as important to facilitate change. To assess ST on the individual level, system attributes have been used when investigating and comparing ST preferences with preferences for reductionism (27–29). There are also attempts made to define and measure ST as a cognitive process (30). Richmond's taxonomy of "thinking skills" (31, 32) has been used in several studies [e.g., (33, 34)], where, for example, more complex ST skills have been linked to better decision-making (33). Measurement of ST on the individual level mostly relies on the subjective judgment of one's experiences or preferences, sometimes in relation to described fictive situations.

Implementation of policy programs typically involves many different types of actors, and, usually, there is a team responsible for the program, which potentially can benefit from ST to address wicked problems and the dynamic changes inherent in them. Some indications of the use of ST on a *group level* have been described in the literature. Different people have different objectives and perspectives, which affects the situation at hand (35, 36). Addressing a complex and problematic situation requires understanding multiple perspectives, and Soft Systems Methodology is one ST approach designed to tackle diffuse real-world problems (37). Mental models of managerial teams' ST have been related to organizational learning processes, especially when the teams' shared understandings and action strategies change (38). More recently, factors that foster collaborative ST in teams have been studied (39). Studies of ST at the group level focus on a mixed social and cognitive process. Concepts described in other research fields, such as shared cognition [e.g., (40)], team mental modeling [e.g., (41)], sense-making as a social process [e.g., (42, 43)], and team learning (44), can aid the understanding of the use of ST in groups. Finding ways to achieve shared cognition and team mental models among key actors involved in policy programs is important to achieve systems change (45, 46).

Operationalization of ST *on the organizational level* is also scarce. Indicators that can provide insights into how and to what extent organizations apply ST are limited or even seen as lacking, especially within the public health domain (22, 47). Smith et al. (47) have recently proposed a framework for ST in public health, which combines ST, collaborative inquiry and action, and systemic science and methods. The framework is based on previous public health frameworks (48), and the framework's initial concepts (49) were further refined drawing on insights from public health scientists and practitioners with experiences from nine policy programs (22). It has been further operationalized and tested by Wilkins et al. (22), and eight principles of a systems orientation have been proposed (Table 1). Wilkins et al. (22) also developed and tested quantitative indicators of the ST principles within organizations (i.e., state public health departments) focusing on the area of state injury and violence prevention. Their attempt

Abbreviations: ST, Systems thinking; SSM, Soft Systems Methodology; WHCP program, The improving Women's Health and Care before, during, and after Pregnancy program; NBHW, The Swedish National Board of Health and Welfare; SALAR, The Swedish Association of Local Authorities and Regions.

TABLE 1 Definitions of the eight principles of ST on the organizational level (22).

ST principles	Definitions
P1. Convene partners	Bringing together partners to (1) identify gaps and needs, (2) identify assumptions, (3) identify high-leverage points, (4) identify high-leverage solutions, (5) evaluate the process, and (6) disseminate data. Partners should include those who have diverse content expertise and expertise across multiple roles; reflect the unique attributes, culture, and characteristics of the community; have decision-making power; and are likely to bring a divergent perspective. This also includes intentional strategies for engaging partners (such as identifying common ground) and for strengthening the quality of partnerships (such as building trust and improving communication).
P2. Seek understanding	Gathering information from the community to better understand challenges, learn about community culture, and identify strengths. This includes acquiring and assessing various sources of data and evidence that are relevant to the context and the questions being asked. It also includes identifying what contributes to community challenges, how these contributing factors relate to one another, and how making changes to these contributing factors may influence health (and other) outcomes, and/or potentially lead to unintended consequences.
P3. Surface assumptions	Identifying partners' and stakeholders' "mental models" or assumptions about the community, its challenges, and the solutions needed to improve its health. This process also includes identifying gaps between different mental models held by various partners.
P4. Reflect and learn	Continually reviewing emerging information, identified assumptions, and lessons learned to collaboratively develop and refine a shared vision for improving community outcomes. This includes creating environments in which people are encouraged and supported to regularly reflect and learn from emerging findings, and to contribute to practice-based research.
P5. Find leverage	Identifying solutions, innovations, and public health actions that are likely to be appropriate for the needs of the community, efficient, high impact, and sustainable. This includes solutions that (1) are based on data and have demonstrated impact in similar communities, (2) address "upstream" factors and social determinants that contribute to community challenges, (3) are uniquely tailored and combined to have the most impact in the local context, (4) galvanize broad support and coordination among partners, and (5) support efficiency and sustainability by improving public health infrastructure.
P6. Manage resources	Leveraging and coordinating existing resources, such as funding and staff, to support and sustain collective action. This includes cross-training or co-locating staff to facilitate coordinated activities and braiding funding streams to adequately and sustainably support them.
P7. Respond rapidly	Alongside collaborative partners, taking action and continuously improving solutions as issues, data, and lessons learned emerge. This includes discontinuing strategies that are unsuccessful, amplifying those that are working, catalyzing action among partners and stakeholders, addressing unintended consequences, and re-evaluating priorities when needed.
P8. Translate findings	Synthesizing and sharing relevant findings, data, and information with partners, stakeholders, and the public. This includes engaging partners and key stakeholders in the process of determining which findings and information are important to share, and the best ways of disseminating and packaging that information.

is focused on evaluation and is considered a first step "toward measuring ST at the organizational level in public health" [23, p.76]. Their study provides quantitative indications of an ST aspect in terms of numbers, presence or absence, or percentage, e.g., Convene partners—the number of internal (health departments) and external partners engaged to advance injury and violence prevention activities/strategies/programs/policies per year. It is proposed that such indicators can be used to identify ST in an organization. However, it does not provide a detailed description of how ST is used in practice or describe strategies that can aid those who work with soft-law initiatives addressing ill-structured or wicked problems.

This study focuses on how ST was used in practice within a national soft-law initiative that addressed several wicked problems and was launched in a decentralized healthcare system. To find indications of if and how ST is used in practice within such policy program, observations of individual skills and social and cognitive processes in groups would benefit from being complemented with other indications (22), and Wilkins et al.'s ST principles have a potential to enrich our understanding of how ST reveals itself in practical activities and the action strategies used within a policy program.

This study aimed to investigate how ST is expressed in practice in complex policy programs addressing wicked problems and describe the specific action strategies used in practice in a national program in Sweden, using a new conceptual framework comprising ST principles on the organizational level (22) as an analytical tool. Providing narrative descriptions of how ST is used in practice, complementary to Wilkins et al.'s (22) test of indicators, can aid others involved in similar soft-law initiatives and policy programs. The underlying assumption behind the study is, in line with previous research, that ST can facilitate change and development within public health [e.g., (10, 13, 14, 16, 49)], by promoting a more holistic understanding of complex social phenomena in complex settings and by supporting collaborative approaches to address ill-structured problems.

2. Materials and methods

This explorative case study uses a rich set of longitudinal data collected during the multi-year implementation of a national policy program in Sweden. The program was chosen partly due to convenience (i.e., access to data) but mainly due to its complexity, representing a comprehensive policy program aimed at several large improvement areas representing wicked problems within a large, complex national setting comprising many geographical areas (i.e., 21 self-governed regions), types of care providers (primary and specialized hospital care, and public and private providers), types of care (e.g., delivery care and neonatal care), units (e.g., primary healthcare units and delivery care clinics), and actors. The study was reviewed by the Regional Ethical Review Board

in Stockholm, and they found a formal ethical approval was not needed (ref no. 2018/620-31).

2.1. Empirical setting—the Swedish healthcare system

The Swedish healthcare system is comparatively decentralized and divided into 21 regional self-governing authorities and 290 municipalities. The regions, which vary in size and demography, are responsible for the provision of healthcare services, and the municipalities for providing home healthcare and social care. The Swedish Association of Local Authorities and Regions (SALAR) is a member organization representing the self-governing regions and municipalities and, as such, is an influential policy actor. Healthcare is mainly tax-funded, and most care providers are publicly owned. Maternal healthcare is provided at outpatient maternal healthcare clinics led by midwives (50). These clinics work with health in connection to pregnancy, support to families, contraceptive counseling, and public health. During pregnancy, women have access to free controls starting from weeks 8 to 12. Unless there is a health problem, women do not see a doctor during the pregnancy. After pregnancy, routine post-partum care is offered (50).

Improving Women's Health and Care before, during, and after Pregnancy program (WHCP program) aims to affect an extensive system, i.e., maternity care, antenatal care, delivery care, post-partum care, and, from 2018, neonatal care, in all 21 regions. The organizations of these subsystems have regional variations. Maternity can be part of the same subsystem as delivery care and gynecology or be organized under primary healthcare. The variation also concerns the number of private care providers, mainly offering maternity care before childbirth. Private care providers were essentially absent in some regions and more common in the large urban regions.

2.2. Characteristics of the national policy program

The program was initiated in late 2015 to be implemented between 2016 and 2019. It is based on agreements between the national and regional political levels, i.e., between the Ministry of Health and Social Affairs and SALAR, the latter a national organization representing the 21 self-governed regions that attend to, support, and coordinate the regions' common interests. Instead of addressing the complex challenges and (wicked) problems via laws or regulations, they were addressed by an agreement that the regions would put efforts into improving certain areas, based on and adapted to the local situation, and receive funding for this from the government. The agreements were based on mutual trust rather than on control or enforcement. The first agreement was followed by several additional agreements, increasing the scope of the program, and extending the implementation period until the end of 2023. Thus, the implementation of the policy program stretches over almost 9 years. The program aims to improve women's sexual and reproductive health and maternity, antenatal, and post-partum care. The agreement is more decentralized than some previous ones [e.g., (51–53)] where the funding was linked to performance measures.

In 2015, a national program team was formed at SALAR, responsible for leading, coordinating, supporting, and following up on the program's progress and its outcomes. This team had little mandate to enforce the program and did not influence the allocation of the program's finances, which were sent directly to the regions. In 2018, the national program team developed a strategic plan based on the agreement, see Figure 1—adapted from (54), which formed the basis for the forthcoming program. The strategic plan visualized and described the program vision, goals, prerequisites, and overarching strategies.

The program is decentralized, implying that the 21 regions are responsible for identifying needs, prioritizing, and implementing interventions to improve their work within the strategic areas of the program. Regional contact persons, appointed by the director of health in each region, function as the nodes for contact and interaction with the WHCP program team at SALAR. The funding was distributed directly to the regions based on the size of their population, with a smaller amount designated to the program team, and the funding for some special missions was given to public authorities, e.g., the National Board of Health and Welfare (NBHW). Thus, the regions could decide how to distribute the funding to reach the goals of the program, based on their knowledge of the regional and local conditions. The Swedish Agency for Health and Care Services Analysis was given the mission to evaluate the program's outcomes.

2.3. Data collection

Since 2017, data about the program have been collected and compiled in a comprehensive case study database by external researchers (among them authors MEN, ST, and VS), as a part of a longitudinal (still ongoing) research project. The database consists of semi-structured individual and group interviews conducted with program team members (2018–2021), contact persons from all regions (2018 and 2020–2021), and external program evaluators (2020); non-participant observations of meetings (2017–2022); and documents (e.g., reports, evaluations, policy documents, meeting agendas, and presentation material), survey data, quality registry data, and national and regional publicly available statistics.

In this study, we have used a representative sample of interviews, observations, and archival data sources chosen to represent various types of data, content, actors, and time periods from the database which cover a 5-year period (March 2017 to March 2022), excluding outcome data, i.e., quality registries (Table 2). The sample consisted of 12 interviews with the program team (2018; 2020), 4 representative interviews with regional contact persons, 20 observations of meetings and conferences (2017–2022), and 34 documents (2016–2022). Interviews with the program team and with contact persons covered similar themes: national or regional program organization; strategies and activities; conditions and enabling and hindering factors; communication; support; follow-up and evaluation; effects; learnings; and plans for the next year. In two rounds of interviews, the program team members described their experiences of situations, important activities,

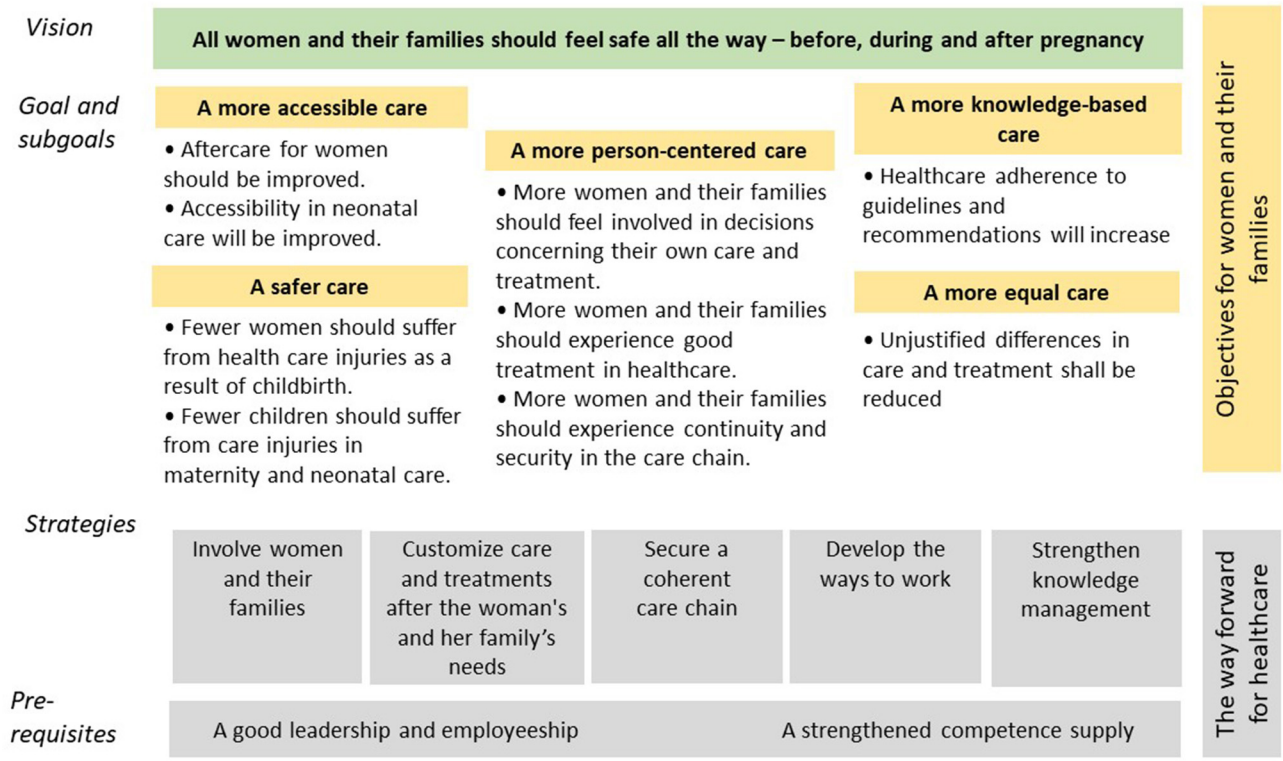

FIGURE 1
Strategic plan of the WHCP program.

perceived effects, and, if they can, the intentions and rationales behind them. Interviews contain both current and retrospective data. Interview guides can be found in Supplementary material 1–4. Interviews with regional contact persons were added to represent their experiences of the program activities and action strategies. Twenty non-participant observations of activities performed within the program and their detailed content (i.e., what was presented and discussed) were collected. The observation template and an example of observation data can be found in Supplementary material 5. Descriptions of activities and their content could be found in documentation, i.e., archival data (see Supplementary material 5 for examples of different types).

2.4. Data analysis

The definitions of the eight ST principles (see Table 1) in the refined conceptual framework (22) were used to identify and categorize indications of the practical use of ST within the program.

First, the researchers familiarized themselves with the eight ST principles by discussing examples of what type of program content and data potentially could contain indications of the principles (Table 1). Then, relevant data sources, representative of the program process over time, were identified and selected from the large database (Table 2).

An iterative approach based on deductive content analysis (55) was applied using the definitions of the principles in the framework (22), presented in Table 1. Multiple data sources (e.g., interviews and archival data) were used to triangulate information about activities and expressed strategies fitting the definition of each principle. The first step of the analysis was performed by two researchers (ST and MN) by coding data information in the data sample using the principles in the framework. After sharing these extracts, all four researchers met in six 1–3 h-long meeting sessions to scrutinize and further discuss the interpretation of the identified text in relation to each principle and to reach a consensus on program findings that could represent the principles, if found. The procedure intended to ensure reliability and validity in the interpretations of the qualitative data and resulted in a few alterations of the narrative descriptions used (i.e., one activity description was not used, and one was placed under another ST principle). Interview quotations and extracts of text used for the illustration of the principles were chosen during this process. Finally, a synthesis of data on each principle, including identified action strategies, formed the basis for a narrative description of how ST was used in the program.

3. Results

In this section, narrative descriptions are presented about how the organizational level ST principles (P1–8), put forward by Wilkins et al. (22), were applied in practice in the WHCP program. For each principle, examples from different data sources can be found in Supplementary material 5, while Tables 3–10 provide the action strategies and detailed examples for each principle.

TABLE 2 WHCP program case database, from which data were selected and analyzed in the study.

2015-11-01 to 2022-12-31 data sources 2017-03 - 2022-03	Specifications	Data	Data analyzed in this study
Interviews ($n = 58$)	- National program team	- 2018 ($n = 6$); 2020 ($n = 6$) tot 12	- 12 interviews
	- Regional contact persons	- 2018 ($n = 23$) 2020 ($n = 22$) tot 45	- 4 interviews
	- Evaluators	- 2021 ($n = 1$)	
Observations ($n = 54$)	- Program team meetings	- 2017-2022-02 ($n = 27$)	- 10 observations
	- Contact person meetings 2–4 h	- 2017-2022-02 ($n = 15$)	- 8 observations
	- Contact person conferences 4x2 days	- 2017–2020 ($n = 8$)	- 2 observations (of 2 conferences x 2 days)
	- National meetings/workshops-−1 day	- 2017–2019 ($n = 1$)	
	- Regional meetings 6 h-−1,5 day	- 2017–2020 ($n = 6$)	
Archival data ($n = 263$)	- Agendas for the above meetings	- 2017–2022 ($n = 61$)	- 25 documents
	- PowerPoint presentations from meetings	- 2017–2022 ($n = 73$)	- 9 documents
	- Reports and web reports—SALAR	- 2017–2022 ($n = 17$)	
	- Reports—Evaluators	- 2017–2022 ($n = 2$)	
	- The 21 region's yearly activity reports	- 2017–2022 (5x21=105)	
	- Other documents	- 2017–2022 ($n = 15$)	

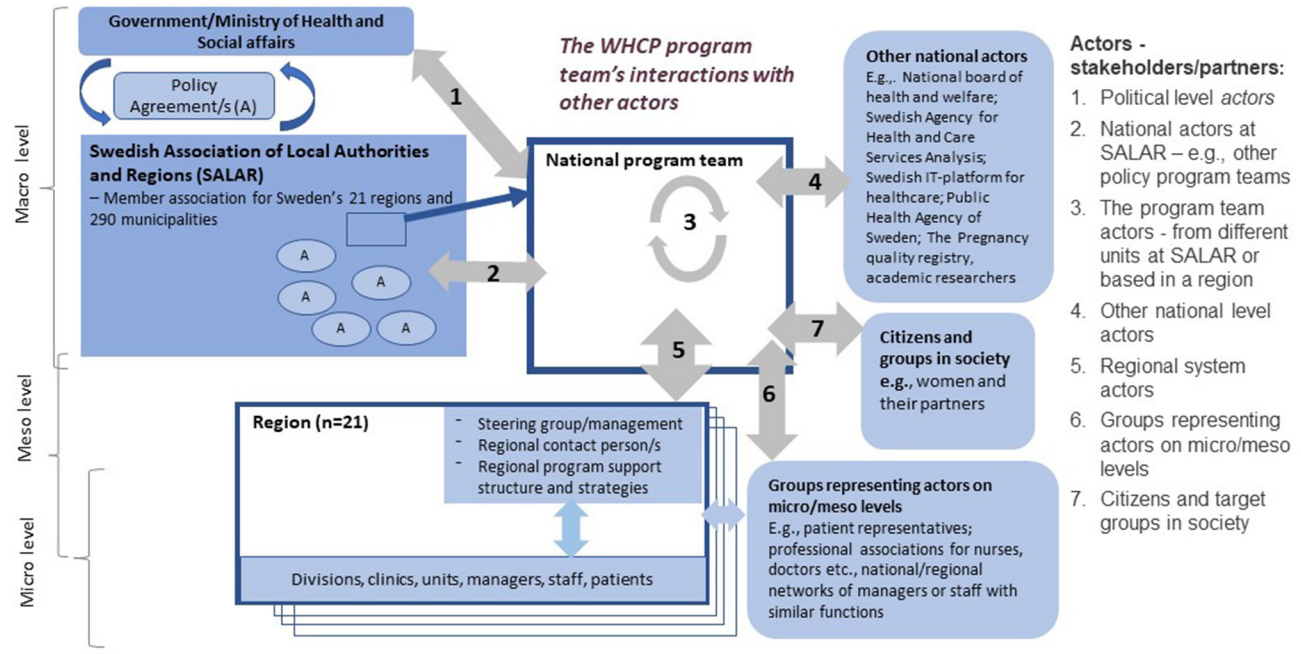

FIGURE 2
Overview of the types of actors involved in the national program.

3.1. Principle 1—convene partners

The principle Convene Partners concerns identifying, reaching, involving, and engaging the right actors at the right time and comprises both the variety of involved stakeholders and partners and what they do together, which includes the forthcoming principles. How to identify, reach, and involve the right actors at the right time depends on the complexity of the program and its setting.

To address the issues and reach the WHCP program goals of a more equal, accessible, safe, knowledge-based, and person-centered care for women over the entire country meant identifying and involving many different actors and professions from different

TABLE 3 Principle 1—convene partners expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P1 convene partners	Engage a multi-professional program team	Team members were deliberately chosen by the team leader to represent a variety of professional expertise and experience from different parts and levels of the healthcare system (e.g., public health, maternity care, communication, and HR).
	Create a network of regional contact persons	A network of appointed contact persons in each region was established. Forums for interaction were mainly via group meetings (e.g., regional conferences, dialogue tours visiting all regions, digital and face-to-face meetings, and workshops and program-specific web-based collaborative platforms). This partnership was initially used to clarify expectations and enhance interactions across system levels but developed over time to involve all ST principles.
	Interact with national authorities involved in similar issues	The team interacted with actors from several national authorities, e.g., NBHW, The Swedish Public Health Authority, and key actors, such as the national healthcare IT platform and representatives from the Ministry of Health and Social Affairs.
	Collaborate with program teams leading other national policy agreements	The team collaborated with other national policy agreements in related areas such as the agreements on developing a national structure for knowledge management in healthcare; improving available and person-centered primary care; and improving the situation for women subjected to physical, psychological, or sexual violence.
	Involve external program evaluators and academic researchers	The program team engaged with the external program evaluators and a group of academic researchers following the program and invited them to participate in and contribute to program activities.
	Interact with existing social networks	Some networks were readily available and hosted by SALAR, (e.g., networks of regional politicians, healthcare directors, and HR directors). Others were networks of representatives from professional organizations (e.g., the Swedish Association of Midwives) or actors with specific functions (e.g., the national network of midwives with a coordination function in their organization). These arenas were mainly used to spread information and to get input and feedback on planned or performed activities.

parts and levels of the healthcare system, from politicians to patient representatives. This was recognized by the program team members and described in interviews as being important from the start of the program. It was also visible in the amount and type of actors involved in the various program activities over time (see Figure 2). Different actors were involved in the identification and **analyses** of challenges, problems, and contextual influences and in problem-solving, planning, and follow-up activities, either regularly or for limited periods of time. This ensured that many perspectives could be considered when planning and implementing program activities. The regular interaction with other national authorities and programs was perceived by the program team members to reduce the risk of launching competing activities. The interaction with and consideration of the different actors and their interests require significant amounts of time and skills on behalf of the program team. Reaching and involving higher regional decision-makers was difficult. They were informed when the program was initiated and later in their monthly national meetings. Depending on the chosen regional contact person and regional strategy meant that key actors on a higher regional level could have been more or less involved in the realization of the program intentions. The team coordinating the program at the national level was based at SALAR, which is a members' and an employers' organization for all the regions in Sweden. This created unique opportunities for the team to get a national overview and facilitate linkages between national and regional levels. This platform secured a mandate to facilitate collaborations and coordinate ongoing system changes. Due to the decentralized approach regarding regional power over the choices of problem areas and interventions, the regional contact persons were key actors in stimulating regional change. The five main action strategies identified are described in Table 3. Figure 2 provides an overview of the types of actors involved in the program and the action strategies used.

3.2. Principle 2—seek understanding

The principle Seek Understanding concerns gathering information from the context to better understand what contributes to challenges and strengths, how these contributions relate to each other, and how making changes to these contributions may influence outcomes and potentially lead to unintended consequences.

The WHCP program comprised several multi-faceted issues, e.g., equity in care, attracting and keeping competent staff, patient safety, availability of care, person-centered care, and integrated care. How to understand this range of issues, what contributes to the challenges and also consider regional variations and context-specific conditions for providing healthcare, was addressed in meetings and some team members expressed in interviews as a challenge.

The analyses of problems and needs were an important strategy on behalf of the program team. Mappings and gap analyses were conducted and presented in reports and then communicated, discussed, and reflected on during several meetings with regional actors. Monitoring different media also became important for understanding the region's various conditions and challenges. The program team's efforts to gather information to better understand regional and contextual challenges, often together with program stakeholders and partners, were perceived to contribute to a better understanding of both the system features and the complex improvement areas the program aimed to affect, especially for new members in the program team and contact persons, and also for others involved, for example, from national authorities. The strategic plan developed in 2018 (Figure 1) was an important tool for aiding the understanding of the program, especially as

TABLE 4 Principle 2—Seek Understanding expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P2 seek understanding	Perform problem analyses, needs assessments, knowledge reviews, gap analyses, and review existing solutions	Seventeen public reports were produced in 7 years, addressing initial and emerging problems and needs, identifying gaps, and discussing various ways to address them. The initial report on the status of women's sexual and reproductive health and healthcare services in 2016 identified areas in need of improvement. A deeper analysis followed in 2018 complemented by a report identifying several ways to improve the identified challenges. The reports were perceived by contact persons as supportive of their regional work.
	Arrange arenas with regional representatives to collaboratively seek an understanding of the program issues in varied settings	To manage and understand the complexity the team developed program activities, such as network meetings and workshops with regional contact persons and other regional representatives with a mix of competencies and professions, to analyze program issues in detail and in variable contexts.
	Perform dialogue tours to each region to discuss the regional situation	Yearly visits initiated in 2018 covered meetings with decision-makers and representatives from various parts of women's healthcare (e.g., maternity care, antenatal care, delivery care, post-partum care, and neonatal care) and provided complementary information on regional conditions and needs and perspectives on the strategic areas. The wide range of issues addressed by the program was discussed with all regions in 2018. Regional differences in how care was organized and functioned and in perceived problems to support care providers and implement the program were revealed.
	Develop and visualize a strategic plan of the program areas, goals, and strategies to aid understanding of the program	Early in the program, regional representatives asked for clarification on what was expected of the regions. A clarified and visualized strategic plan of the main parts and strategies of the program was developed by the program team in 2018 and presented in the report 'Strategies for women's health'. Constructing and visualizing the strategic plan was an attempt to clarify the overarching goals and describe the program logic and the general strategies to achieve the goals. The team used the plan in meetings with regional representatives and in the dialogue tours.
	If information is lacking for developing ways to gather information on women's experiences	In the focus area of person-centered care and the strategy to involve women and their partners, available information on the women's experiences of care before, during, and after childbirth was scarce. Therefore, the development of a National Pregnancy Survey was initiated. In 2021, the first results from this survey were presented in a report.
	Monitor, engage, and discuss activities of related national policy programs and projects with stakeholders to build a holistic and mutual understanding	The team regularly monitored the activities of national stakeholders, e.g., NBHW, the Swedish Agency for Health Technology Assessment and Assessment of Social Service, the Swedish Food Agency (breastfeeding), and the Public Health Agency of Sweden. Stakeholders from related programs and government missions (e.g., authorities developing new clinical practice guidelines) were invited to discuss their work together with the contact persons, and opportunities for mutual understanding were provided. Concurrently, the team let stakeholders know what was happening in the WHCP program. Interrelations among ongoing national policy programs at SALAR were highlighted and discussed in meetings and persons working in other programs in nearby areas were engaged in the program team, e.g., by part-time employment.
	Monitor information presented in media on the situation in the regions	Delivery care was of high interest to the media during the period and media reports had an impact locally and regionally and on the program team's work on the national level. The team's communication officer monitored media reports, more intensively from 2021 and onwards after the launch of the National Pregnancy Survey and a growing concern about the increasing shortage of midwives in many regions. During this period, media reports were discussed in program team and contact person meetings and on the program's IT platform.

TABLE 5 Principle 3—surface assumptions expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P3 surface assumptions	Clarify the underlying assumptions of the policy agreement and about the WHCP program	The strategic plan (Figure 1) developed by the program team was based on an interpretation of the text in the basic agreement and the additional agreements. The input was asked for in meetings with regional representatives, contact persons, professional organizations, and key actors from the National Quality Registries. This was a process of uncovering the political assumptions behind the program and surfacing and integrating the operational and professional perspectives. The range of perspectives represented by the program team members aided the process. The plan became an important tool for communication and for uncovering assumptions about the program held by various actors.
	Clarify the role expectations of the regional contact persons	Partly due to turnover among the contact persons, a need emerged to identify their assumptions, especially the new contact persons, to quickly get them into gear. This led to discussions on the expectations of the contact person and the regional conditions for fulfilling this border role. An introduction kit for new contact persons was developed to aid their enactment of the role.
	Invite stakeholders to discuss issues, challenges, and strengths of the program	The program team invited stakeholders (e.g., representatives from national authorities or staff working with related national agreements) to discuss issues related to the program with the team and with the regional contact persons, and thereby provide their views and perspectives.

each region could, based on their context-specific needs, choose which areas of the program to focus on and which interventions to use. The seven main action strategies identified are described in Table 4.

3.3. Principle 3—surface assumptions

The principle Surface Assumption concerns identifying partners' and stakeholders' assumptions about the focus areas

TABLE 6 Principle 4—reflect and learn expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P4 reflect and learn	Enhance open reflection in groups	Open reflection in smaller groups at the beginning of each meeting with the contact persons. During these sessions, the contact persons can share thoughts and discuss current issues in their regions and their need for support. The small group discussions are followed up in the large group, and suggestions on actions are discussed. This approach became more important during the pandemic.
	Provide national and regional arenas and opportunities for reflection and learning with the regions and their actors	The dialogue meeting tours, where program team members visited the regions to discuss the program intentions, results from National Quality Registries and patient surveys in relation to the current regional situation, were planned to provide opportunities for discussions, reflection, and mutual learning. This same approach was used in the contact persons meetings including open reflections in smaller groups. National conferences with interactive workshops for a broader target group were organized regularly. These workshops focused on, e.g., how to develop care together with pregnant women and their families, create equal care, use staff competence wisely, or develop an integrated care process. The mix of participants created opportunities for people with different perspectives to meet and reflect together.
	Offer courses and seminars	As part of the program, there were offers for regional staff to, without any costs, participate in courses and seminars covering subjects relevant to change and development (e.g., leading change, service innovation, and analyzing and using data for improvement from the National Pregnancy Survey).
	Encourage and enhance reflection and learning within the program team	From the start, the team allocated time and resources for sessions dedicated to team learning and team building, e.g., one Inspiration Day per semester each year. In addition to weekly operative meetings, the team had monthly half-day meetings, which created opportunities for in-depth discussions, reflections, and mutual learning about subjects that could be suggested by any team member.
	Invite external researchers to follow the program process, provide feedback on findings, and summarize learnings	Researchers were invited to follow the program using a learning and action-oriented approach. The researchers provided feedback to the team and to regional partners during the program and identified and summarized learnings to be used in future national policy programs and research publications.

and the program and the challenges and solutions needed to improve care and women's health. The overarching goals and structure of the program were set in negotiation between actors representing the government, politicians, and decision-makers from the regions and representatives from SALAR. Thus, the agreement was originally based on the mental models and assumptions of those involved in negotiating, writing, and signing the agreement, mirroring mainly a political perspective on issues and on what constitutes good care for women before, during, and after pregnancy. The negotiations resulted in a high degree of freedom regarding the implementation of the agreement, and the goals were rather general to suit stakeholders with divergent needs (see Figure 1). Due to the program's comprehensive character and being a national initiative aiming to influence processes in the autonomous regions, the program team would need to identify the underlying assumptions held by actors on multiple system levels, which could reduce confusions and conflicts, and facilitate the program team's choices of implementation support.

The program team worked to surface assumptions held by stakeholders directly involved in the implementation, and those held by the contracting parties in the policy agreement, i.e., the government and SALAR. This is partly expressed in Principle 2 in the ways the team tried to seek understanding by involving different actors, but it was not explicitly described in the team members' interviews as a strategy. For program team members and contact persons, the knowledge gained on different perspectives and assumptions would increase their awareness of the existing and contradicting views when planning or adapting program activities. However, most of the analysis of actors' assumptions, mental models, and potential conflicts of interest did not occur during the actual meetings with the invited stakeholders, but rather in discussions after these meetings. Deeper analyses of stakeholders' mental models and the potential effect of contradicting assumptions did not occur as often as the discussions aimed to reveal or clarify them. We found no indication that this principle was used with the higher-level regional decision-makers, whose assumptions can affect the program implementation. The three main action strategies identified are described in Table 5.

3.4. Principle 4—reflect and learn

The principle Reflect and Learn concerns continually reviewing new information, assumptions, and learnings to jointly be able to develop and refine a shared vision for, in this case, the improvement of women's sexual and reproductive healthcare. An important part of this principle is to create environments where people are encouraged to reflect and learn.

Initially, the program team focused mostly on spreading information about the program and less on creating opportunities for mutual interaction. However, the focus shifted and efforts to create opportunities and arenas for reflection and learning increased over time. We found many indications of the use of this principle in the program activities and in the described action strategies (see Table 6). The arenas and opportunities to review new information, reveal assumptions, and reflect and highlight lessons learned increased over the program period. From having contact persons meeting twice a year to meetings every month plus two 2-day conferences each year. This development within the program team resulted in the discussion of if and how suggestions, activities, and solutions stemming from different actors, and their perspectives should be incorporated into the new yearly agreements or in the implementation of the program. The arenas and opportunities used for reflection and learning were perceived by program team members to have increased the capacity for change among actors in the regions. Mutual reflection and

TABLE 7 Principle 5—find leverage expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P5 find leverage	Identify issues, gaps, and areas in need of improvement, and knowledge on the best ways to improve and summarize them in reports.	Reports on issues, gaps, and potential solutions were based on data from the regional reports, interviews, quality registries, and the National Pregnancy Survey, e.g., mapping the clinical pathway before, during, and after pregnancy, current patient characteristics, and improvement needs in the 21 regions, and identify good examples potential successful approaches for decision-makers to manage these needs.
	Spread knowledge, methods, and good practical examples of how to deal with issues and gaps via meetings, conferences, and webinars	The main arenas for spread were contact-person meetings, national conferences for regional actors, and a webinar series. Efforts were made to spread existing evidence-based knowledge on specific clinical methods expected to have a high impact once implemented. For example, a method to prevent perineal trauma during labor found to be successful in other countries was presented at a national conference in 2018 that spread to many regions. Reports were also used as a basis for a webinar series covering several multi-faceted issues and targeting staff in maternity care, antenatal, and post-partum care. The aim was to spread knowledge and examples of good practice solutions to challenges identified by the team or the contact persons.
	Highlight upstream improvement areas that affect other program areas—e.g., the shortage of midwives	A pervasive problem concerned with attracting, recruiting, and retaining competent staff. There is a shortage of midwives in all the regions in Sweden and managing the turnover of competent healthcare staff is an increasing challenge due to demographic changes. This issue affects the work of improving several program areas. During the program, this issue was regularly addressed in meetings with regional actors, and combined solutions were discussed.
	Increase the regional capacity and knowledge about how to facilitate innovation, improvement, and change	Developing the regional capacity to facilitate innovation and improvement, and to spread and sustain high-impact solutions was identified as important to enable regional actors to implement the changes needed. Examples of activities in this area were the offer of a free 3-day course in leading change, workshops, and a course on how to work with service innovations, and seminars and discussions on ways to achieve learning and change with input from researchers.
	Use the strategic plan as a guide for overarching improvement strategies and goals	The strategic plan presented an overview of the program's focus areas and main improvement strategies. The team used the plan as a guiding tool to find, organize, and spread existing knowledge and, to some extent, identify potential high-leverage solutions to issues within each program area.

learning were adapted to the medium used for the meetings (face-to-face or digital meetings) and the time restrictions (length and regularity of meetings). The known effects of the team's attempts to enhance learning to aid program implementation in the regions are limited. The five main action strategies identified are described in Table 6.

3.5. Principle 5—find leverage

The principle Finding Leverage concerns identifying solutions, innovations, and actions that are efficient, have a high impact, are sustainable, and meet the needs of the community, in this case, those delivering care to women in all regions before, during, and after childbirth. The solutions should be based on data, address "upstream" factors, be tailored to the local context, provide support, aid coordination among involved partners, and improve infrastructure (in the area focused on).

Finding high-leverage solutions to the many issues in the WHCP program that could have a high effect nationwide, and in the complex settings of 21 different regional systems, was important but challenging for the program team. Efforts were made to identify and analyze problem areas, spread existing knowledge, and successfully test innovations in each of the program's main goals and strategies (Table 7). Analyses of issues and identification of gaps and knowledge were done both to seek understanding (P2) and to find successful solutions (P5). The generated reports formed a basis for other activities, e.g., webinars and workshops. Developing the regional capacity to facilitate innovation and improvement and to spread and sustain high-impact solutions was identified as important to enable regional actors to implement the changes needed in the program's focus areas. However, although the interrelations among the focus areas and how the issues could be tackled in integrated ways were sometimes discussed within the program team and briefly together with other actors, potential solutions or examples of them were not made as explicit or clearly presented in meetings as the solutions found on single issues or within single focus areas. The five main action strategies identified are described in Table 7.

3.6. Principle 6—manage resources

The principle Manage Resources concerns levering and coordinating resources in terms of funding, people, technology, and equipment. To manage resources means to allocate them in a strategic way, so they support any chosen intervention's impact and follow-up on the results. This can, for example, involve temporal aspects, choices of high-leverage solutions, or prioritizing between target areas.

In the WHCP program, the needed changes outlined in the national policy agreement were to take place in, and ultimately be managed by, the self-governing regions. This limited the mandate of the program team to manage resources in relation to the change process, compared to what might be the case in organizations. Since the program was based on a series of separate, but related, policy agreements between the government and SALAR as a representative for all the regions, funding varied over time as new agreements were settled. The program team at SALAR received funding for coordinating national activities to support the regions' improvement efforts, but the main part of the resources was directly transferred to the regions, based on their population size. The

TABLE 8 Principle 6—manage resources expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P6 manage resources	Develop a mixture of methods for following the regional work and program progress	The program team's awareness of the restrictions in terms of managing resources led to a focus on follow-ups of the regional work and progress and the gradual development of a mixed way to select and use collected information to influence resource allocations and direct them to important regional improvement areas, via content in meetings, dialogue tours and summaries of regional activities.
	Gather and analyze yearly reporting from the regions on how they have used the program resources	The regions reported yearly on how the resources were used, provided information on interventions, and reported on their effects. These activity reports provided timeframes and detailed qualitative information on all activities (completed and ongoing) and estimations on how much funding from the program had been used for activities that had ended. The program team compiled the information provided by the regions in yearly reports. For the 2021 agreement, there was a specific request for detailed information on how the funding had been used in the areas highlighted in this agreement.
	Use the region's yearly reporting to help the region get an overview of funding and activities	The reason for increasing the level of detail in the follow-ups as the program progressed was not primarily to influence how the regions distributed or used the resources locally. Instead, the main purpose was described as a way to collect and compile information to be able to help the regions see their own regional investments in a larger context and how these contributed to the development of maternity care from a national perspective. Another aim of the framing of the questions in the yearly report template sent to the regions was to aid and motivate key regional actors to work with improvements in a systematic way.
	Summarize and send yearly program reports to the Ministry of Health and Social Affairs	The Ministry of Health and Social Affairs as one part of the agreement followed up on the activities initiated by the program team each year, which also included the researchers' yearly report.

TABLE 9 Principle 7—respond rapidly expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P7 respond rapidly	Pick up signals and respond to feedback from various stakeholders	One example of the ability to pick up and use information from various types of stakeholders was the development of one of the National Pregnancy Survey. The process involved collaboration with a wide variety of actors on national and regional levels. The survey went through several changes and adaptations, both before and after it was tested and launched. Changes were made to adapt the survey, information to end-users, and the IT infrastructure, to the needs and comments of partners and stakeholders, often based on input from healthcare professionals and end-users. Another example is during the dialogue tours where the team asked for feedback on the national support and activities—and could provide rapid responses to clarify, adapt, or change planned activities or pick up new ideas.
	Ask for, respond to, and act on feedback from regional partners	One example of adaptation due to feedback from regional partners is the successive changes made to the template for the regions' yearly activity report, which was adjusted several times during the program to become more user-friendly, to fit with new policy agreements, and to provide the information needed for evaluations.
	Use agile consulting approaches to quickly identify contextual changes affecting the program	The COVID-19 pandemic 2020–2022 was one major contextual factor influencing maternity and delivery care. To adjust program activities to the unfolding situation, a strategy to frequently consult with the contact persons on the current situation in their regions was used. Most of the planned real-life meetings were then transferred to digital format, and new meeting formats evolved. The strategy was also used to discuss aspects that could contribute to, or affect, the status of issues connected to program areas, e.g., post-partum care or a midwife's work situation. This regular interaction enabled the program team to pick up signals and respond quickly to changes affecting the program.
	Respond quickly to contextual change affecting healthcare	A quick adaptation of planned program activities happened in 2020–2021 due to the COVID-19 pandemic. The pandemic had a major impact on the healthcare system and on maternity care, e.g., during periods of high infection rates in the regions the partner could not accompany the pregnant mother to visits, nor participate during the delivery.

regions then allocated these program resources according to local needs and regional priorities. Thus, in practice, the national level had little control over how the resources were allocated and had to find ways to get information from the regions. Initially, the program's reporting requirements were neither very strict nor detailed, but successively requirements changed and increased, and the regional activity reports gained more importance over time.

The national level had two primary means to influence the allocation of resources within the regions. The first was the selection of indicators from National Quality Registries and the National Pregnancy Survey used for follow-ups and presented to the regions. The other was the design of the questionnaire-like template for the regions' yearly activity report, highlighting the importance of thinking about the whole change process, including how the resources were used. Therefore, the program team also offered support sessions to the contact persons when it was time to compile the activity reports. For the 2021 agreement, there was a specific request for detailed information on how the funding had been used in the areas highlighted in this agreement. The four main action strategies identified are described in Table 8.

3.7. Principle 7—respond rapidly

The principle Respond Rapidly concerns taking actions and continuously improving solutions or discontinuing unsuccessful

TABLE 10 Principle 8—translate findings expressed in practice in the WHCP program.

Principle	Action strategies	Detailed description
P8 translate findings	Use a customized compilation of regional findings in the regional dialogue meetings	In the dialogue tours from 2018 onward, the program team visited each region to meet with decision-makers and contact persons to discuss the local implementation and issues related to the program, the regional findings from the National Pregnancy registry, the quality registries, and the regional activity reports. The team produced an overview in a few pages where a selection of basic information, good and poorer results was presented and visualized.
	Synthesize information in the region's yearly activity reports	The public activity reports were since 2018 synthesized and shared with partners, stakeholders, and the public. From 2020, the reports were structured according to the categories in the strategic plan. A work group within the team synthesized and packaged information on what was going on in each of the strategic areas and compiled summaries of each region's activities. This summary report evolved, partly as a response to the discussions with contact persons on the usefulness of reporting. The summary report was shared with all regions and openly available on the SALAR website, as all reports were produced within the program. Reports were presented and discussed in meetings with contact persons and used to judge which improvement areas to focus on the following year.
	Summarize findings, e.g., from the yearly regional activity reports—and present them in webinars	The open webinar series used findings from National quality Registries, the National Pregnancy Survey, and the regions' activity reports—to illustrate improvement areas and important themes, and present categories and descriptions of good examples.
	Engage a communication officer in the program and establish a national network of regional communication officers	The communications officer in the program team played a vital role in supporting both the team and the regional actors. This person aided the team when producing reports, websites, and films and in the process of producing information to women about the National Pregnancy Survey and templates for regional reporting of the results to various target groups. A national network of regional communication officers was established to strengthen the ability to translate findings and disseminate and package relevant information to regional target groups.

strategies, catalyzing action among stakeholders and partners, and re-evaluating when needed. A long-term, nationwide program in a decentralized setting that involves many regions, organizations, and people puts special demands on the interaction between the national and the regional and local levels.

The close interaction that the program team developed with the regional representatives led to expectations on the team to respond swiftly to highlighted problems and needs, expressed in interviews and during meetings. The strategies, both for how to find signals and how to respond to them, constantly evolved as information was accumulated and needs discovered, based on discussions with involved actors, mappings, and data from the National Pregnancy Survey and the quality registries. The three main action strategies identified are described in Table 9.

3.8. Principle 8—translate findings

The principle Translate Findings means synthesizing and sharing relevant findings, data, and information with partners, stakeholders, and the public. In this process, key partners and stakeholders will be engaged to determine the importance of information and how to spread it. This process can be more or less of a challenge, depending on the complexity of the problems addressed, interventions used, data collected, and settings where information and findings shall be disseminated. In a large improvement initiative such as the WHCP program, this was a rather complex task.

The intention to translate relevant findings, i.e., prioritizing what information was important to share, with whom, how, and why, together with key actors, permeated the entire program. The ability to translate and use findings in the program increased over time, as more data became available via National Quality Registries, the National Pregnancy Survey, and the yearly regional activity reports. Team members described the use of findings and data to support both improvements and learning. Sharing of data and findings created both an interest in and a better understanding of the program and its focus, challenges, and effects on both partners and stakeholders and in media.

4. Discussion

Aiming to increase the knowledge of how ST is used in practice in national policy programs addressing wicked problems, we searched for indications of ST in data describing the main program activities and action strategies in a national program addressing complex issues in women's healthcare in Sweden. We used a conceptual framework comprising principles of organizational level ST (22) as an analytical tool, and we have provided narrative examples and descriptions of action strategies used in the program for each principle. This differs from the study of Wilkins et al. (22), which focused on organizations working with the implementation of policies, and their work on identifying and testing quantitative indicators of the operationalization of the ST principles in these organizations and within the area of injury and violence prevention. In this study, we have tested a way to retrospectively identify whether and how ST principles were used (intentionally or unintentionally) within a national soft-law policy program where ST had not been discussed or intentionally introduced as a strategy.

The proposed ST principles (22) may seem logical to follow for any project manager. However, the complexity and dynamics of the policy program (its content and organization), the decentralized healthcare system setting, and the multi-dimensionality of the problems addressed pose additional challenges to actors involved in the implementation of the studied program. Thus, the application of ST on a system level is more complicated than in most (single)

organizational settings. Initial understanding and analyses of the system, the issues addressed, and the program features are a foundation for being able to identify stakeholders and important actors to initially involve before considering the other ST principles.

4.1. The use of systems thinking in practice within a national policy program

Improving healthcare, or the health of the population, means dealing with complex issues or wicked problems (2, 3). It is difficult to create a holistic view of a complex program aiming to improve several ill-structured issues and induce changes in a large healthcare system. Similarly, it is difficult to design activities for supporting such changes, since it requires considering multiple perspectives, stakeholders, subsystems, and transformation and adaption processes. The ST principles provide some main categories that can aid the classification and description of the action strategies used in the WHCP program. Some main learnings may aid future attempts to understand and facilitate the use of ST in practice when implementing complex policy programs addressing ill-structured and wicked problems in large and decentralized healthcare systems.

4.1.1. The use of collaborative approaches and ways to shared mental models

To convene actors with a different perspective (ST Principle 1) involve them as partners or use collaborative approaches are not exclusively connected to ST or a policy program. Collaborative approaches are the most often promoted ways to tackle complex issues and ensure that important perspectives of those affected by changes and those that can affect them are incorporated into interventions (56). Individuals and teams involved in the core of developing and implementing national policy programs will have to make decisions, solve problems, and use sense-making to create momentum in change processes, but due to the inherent complexity when addressing ill-structured and wicked problems in a complex system, achieving change is a collaborative challenge involving more actors than in organizational change attempts. To comply with national soft-law policies is not mandatory, but research has shown that the Swedish regions find it hard not to participate in national policy agreements (9). Reasons for this can be compliance mechanisms, such as peer pressure and a sense of moral responsibility, and also SALAR's role as an intermediate actor, i.e., being both the region's representative on the national level and a contracting party in the agreement (9). In this case, there was a shared awareness of the problems in women's healthcare and a readiness for improvements among the regions. The regions also had a high degree of freedom to choose which interventions to focus on within the policy program, based on their own needs, and there were no strict performance requirements or target levels as in some of the previous national agreements [e.g., (51)].

The mix of actors involved aided the processes of understanding and identifying leverage that integrated the perspectives of multiple levels. Engaging actors with decision-making power in the ST processes was also a way for the program team to indirectly try to influence the allocation of resources to enable the intended changes. Still, it was difficult to reach higher-level decision-makers, and the use of separate regional dialogue meetings with a group of regional representatives for each of the 21 regions was one activity that was described as having some impact. For stakeholders, especially higher-level decision-makers, to engage, there needs to be a will and an understanding of the needs and benefits of getting involved in an interactive process of building a shared mental model of the system and the issues to be solved. In a complex program context, it might also be beneficial to further define expectations on a program partner or stakeholder, as their interest and agendas can vary (57). Carefully analyzing and clarifying what types of actors are important to involve and how to involve them can aid the work of a program team. However, the team may need to prioritize and channel their interaction efforts to make the largest impact on the program, especially if resources are scarce.

The composition of individuals in a team leading a program is of special importance. If ST is a guiding approach in large and complex programs, this requires some attention in the initial forming of a team. A clear strategy in the studied program was to include members with different competencies and perspectives, some with connections to other related national agreements, and some with their basic employment in the regions. It is unlikely even for skilled program managers to possess all the capabilities needed to manage a national program focusing on large system transformation. This strategy was also seen as an effective way to extend the team's network, improve communication with stakeholders and partners, and promote an understanding of the program as part of a larger system transformation, i.e., to enhance ST in the team. Previous research on program management has focused on individual program managers and their competencies and actions, but less is known about the nature of the distributed capabilities among other actors in the core and extended program team and how they may contribute to a more holistic view of the program and its change process (58).

The need to address complex and interrelated issues and wicked problems in healthcare in Sweden or elsewhere is not new, but there has been an increase in more complex national initiatives over time. The WHCP program is one example where the goals concern development in a diversity of areas, comprising great challenges. Challenges faced by decision-makers, care providers, and patients may be similar in a general sense, but the dynamic regional and local conditions must be considered when aiming for more sustainable changes (59). Thus, the program team had to consider assumptions and mental models held by actors on multiple levels and develop strategies to connect these views. This was difficult, but the strategic plan, represented also in graphical format, played an important part in this process in several ways. First, by involving stakeholders in the development of the plan, i.e., operationalizing the political intentions expressed in the agreement, which helped to develop a shared vision of the program and its goals, and second, by functioning as a visual communication tool for the team (both internally and externally). Using visualization to represent concepts, components, and their interrelationships is a powerful

methodology within ST that can aid sense-making and the creation of shared mental models (45). Even so, to reveal underlying assumptions in general, and especially of important strategic-level stakeholders and decision-makers on higher regional levels, was less described as a strategy by the program team. Also, higher-level regional managers were hard to reach to inform about and discuss the program, and revealing assumptions would require more interaction. Instead, the program team focused on other regional actors easier to access, such as the contact persons.

4.1.2. An iterative learning strategy and ways to aid the development of multi-level interventions

In a large, complex, and long-term policy program, there are many dimensions and conditions that must be considered to enable reflection, learning, and collaboration among the involved actors. The challenge is to create opportunities and communication arenas that can support collaboration, reflection, and learning, and find and develop ways to deal with ill-structured and complex issues. Achieving deeper learning and changing people's behavior and action strategies takes time. This requirement may not fit very well with the restricted time and/or resources of a program, or with the expectations and views of involved stakeholders and partners.

An important aspect of the program was to provide opportunities and arenas for reflection, feedback, and learning, on group and individual levels. The frequent use of group discussions in meetings is one example. In meetings, there was often a mix of participants from different levels of the healthcare system, which enabled learning and exchange of experiences across national, regional, and local levels. Sometimes, single participants have multiple perspectives, e.g., a regional contact person could also be involved in national groupings, such as producing guidelines. Altogether, the large number of activities designed for enabling interaction, reflection, and learning, such as network meetings, the teams' regular half-day meetings, and numerous workshops and courses, can be interpreted as representing a learning culture within the program, especially on behalf of the program team and the contact persons' network. Active reflection and learning opportunities are at the core of a change process, especially when aiming to achieve double-loop learning for more substantial behavioral changes in both individuals and organizations (60, 61).

Synthesizing and sharing relevant findings and using them to enhance learning and change was a core task for the program team. Interactions and relations with partners and stakeholders were central to the program's communication strategy, which emphasized responsiveness and an adaptive approach regarding how to reach different target groups and audiences. Strategic communication within the program involved a meta-process of integrating information, understandings, and learnings on the program level, making sense of the results in a larger perspective, and choosing the best way to package the information and feed it back to key actors. Management of such processes requires ST skills (30, 33).

One aspect of the learning approach applied in the program was to engage a variety of actors in developing interventions that could affect and improve issues identified in each program focus area. ST has been suggested to aid the process of identifying high-leverage solutions that can address multiple health outcomes (11). The program focused on many interconnected challenges. Finding leverage and multi-level solutions that can affect the whole system and its sub-parts is seen as important (14), but in the decentralized Swedish healthcare context with 21 autonomous regions, it presents a real challenge. The program team used a strategy with iterative reflection and learning loops to build joint understandings and consensus on problems and collaborative approaches to search for interventions to improve issues that could be adapted to various regional and local contexts.

4.2. Multiple and interrelated levels and dimensions of ST in complex policy programs

Understanding ST in use in a policy program involves an understanding of the overlapping nature of the hierarchical system levels in the program context, i.e., national, regional, and local system levels (Figure 2), and the interactions among the organizational, group, and individual-level ST potentially at play in the program strategies.

In the WHCP program, it was important to achieve a holistic view and a common understanding of the program issues among actors in different parts of the system, e.g., politicians, authorities, and professional organizations on the national level, and politicians, public management, and care providers in the autonomous regions. Even so, in-depth discussions to identify gaps between mental models together with partners were less frequent and gaps would typically become evident after some time and discussed in other group constellations. Reasons for this might be the complex political landscape and the dual role of SALAR as both the coordinator of change initiatives stemming from the government and the organization representing the rather independent regions and municipalities (9, 53).

Much of the previous research on how ST can be used in practice has focused either on the individual, group, or organizational level. Combined approaches are scarcer but exist [e.g., (43)]. Figure 3 shows the system levels involved in a large healthcare policy program and examples of aspects influencing ST on each level. The community/society level can be added, but it remains to be seen if ST can be investigated on this level. However, the wider national context and its structure and culture will have an impact on policy programs, and the external context of the healthcare system addressed in such a program must be understood. Among other things, ST highlights "the importance of coordinated and effective interventions across multiple levels of change (e.g., individual, organizational, community) (…) and the critical role of strategic communications to catalyze, coordinate and support change" [25, p. 154–55]. Our studied case provides some practical examples of these aspects, in terms of the action strategies used by a policy program team.

One reason for the limited empirical studies of the use of ST in practice, especially within public health (15–17), might be the complexity of a combined approach and the difficulties of comprehensively presenting such studies. Looking at the

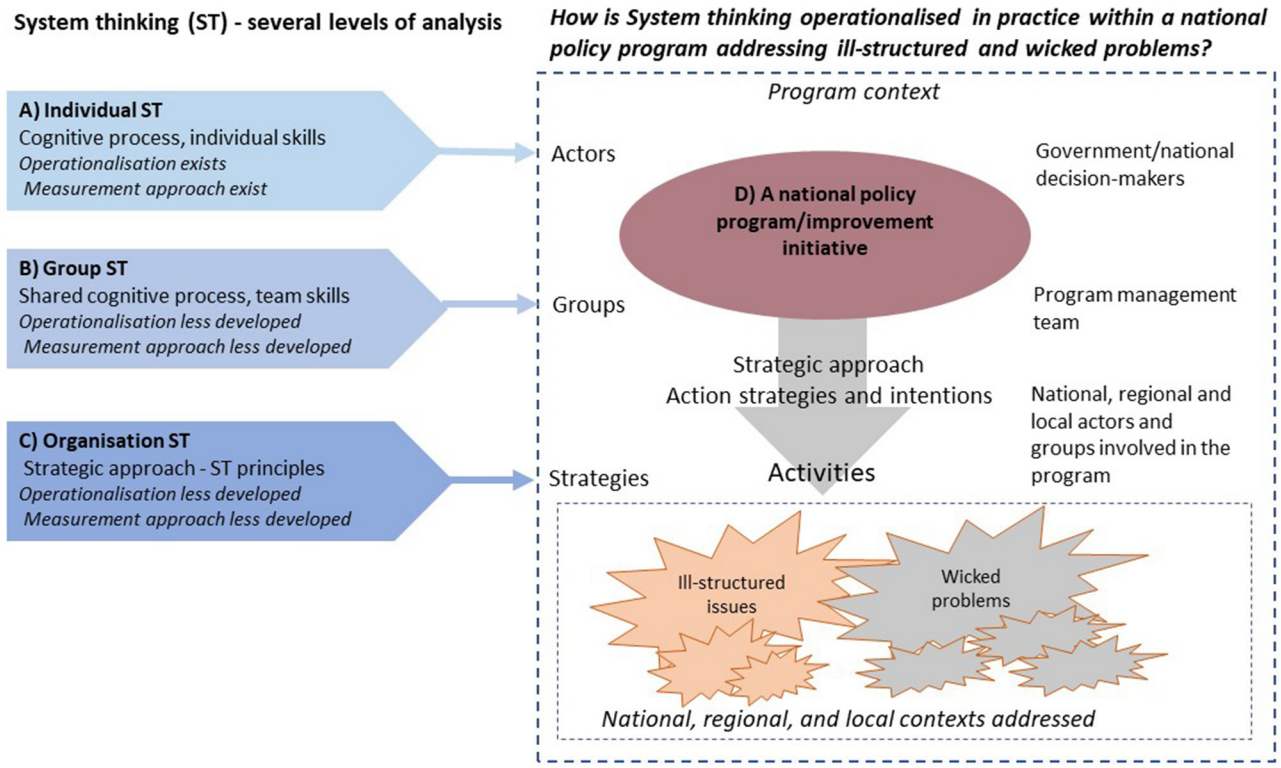

FIGURE 3
Systems thinking (ST) on several levels of analysis in relation to a national policy program.

implementation of a national policy program from an overarching system perspective, it is evident that ST may be used at the individual, group, and organizational levels simultaneously (Figure 3), and that an integrated approach is needed to understand how ST is expressed in practice, how its use can be supported, and assessing the possible impacts of using ST to facilitate change on different levels (individual, group, and organizational levels). For example, it seems important to actively choose a person who possesses ST skills as a program manager, to foster collaborative ST in program teams and regional teams, and to develop action strategies in line with organizational-level ST.

4.3. The usefulness of the framework's principles for identifying ST in practice in complex policy programs

A general observation when applying the ST principles to our qualitative data is that the principles are somewhat overlapping. A holistic view is more evident in some of the principles, and it emerges as the principles are added to one another. Another observation was that as we analyzed the data, we found that multiple principles were enacted simultaneously in each of the main program activities. This study describes the nuances of how ST is used in practice within a policy program context.

It is difficult to judge the effects of the use of the ST principles on the outcomes of the ongoing program as this would require a more extensive understanding of both the issues addressed and the mechanisms underlying the ST principles and the action strategies related to them. In addition, the way ST is used, or not, in the 21 regions needs to be addressed. Also, wicked problems cannot be seen as having linear cause–symptom–effect relationships, they evolve unpredictably over time and involve value conflicts among actors (62). This makes it difficult to assess the impact of ST principles on the WHCP program outcomes; possibly, the impact on involved stakeholders and partners, and their action strategies, could have been assessed, based on additional interviews.

4.4. Study limitations

The study is limited to one case, a policy program. The WCHP program was chosen for several reasons: It represents a complex system (14) as it addresses complex issues and challenges in a decentralized healthcare system; it is a longitudinal program where the opportunities to develop ST have been good, and indications on a comprehensive approach have been described in previous reports (in Swedish). In addition, an extensive case study database exists, where indications of applications of ST can be found. However, we did not analyze all the data in the database in this study, as it was not feasible due to its scope and the time available. All interviews conducted with the program team over time were analyzed, but regarding the other types of data sources (e.g., observations and archival data), a representative sample was selected and analyzed.

An analysis of the total dataset may have yielded a slightly different or more complete and richer picture of ST in practice within the program. However, the researcher's familiarity with the data and the knowledge gained by studying the program for 6 years guided the selection of data. Theoretical generalization (63) can broaden the use of the study but still, the specific conditions of this example from the Swedish healthcare system must be considered.

5. Conclusion

There are some main learnings and implications from using the organizational-level ST framework to identify and describe how ST is applied in practice in the context of a national policy program addressing several wicked problems in a decentralized national healthcare system. Some practical implications may also aid future attempts both to understand and to facilitate the use of ST in policy programs.

First, engaging the right partners in the change process, who represent a broad range of different perspectives and have a mandate to act, is key for enabling ST on the organizational level, but even more so in a national program aiming for impact in 21 self-governing regional systems. Thus, this first ST principle forms the basis for applying the other seven principles described in Wilkins et al.'s framework.

Second, the high degree of complexity of the program content and the variety and dynamics of the settings that a national policy program often encounters create conditions that need special attention from the actors involved. A high degree of program dynamic and complexity executed in a complex program setting require a deeper understanding of underlying principles guiding ST, and more time and effort to plan and execute ST-informed action strategies. The strategies must be used, and adjusted, repeatedly during an extended time period. Such programs will need more resources, time, and competence during their implementation than programs with less complexity.

Third, even very basic use of ST tools (e.g., developing a graphical representation of a strategic plan) can function as important levers for ST in practice in a large policy program aiming for system change. Visualization is a practical tool of special importance if the program and setting complexity are high.

Furthermore, the narrative descriptions of the action strategies related to ST principles provided in this study, as well as the described difficulties encountered by the program team when using them, provide details that can aid others who lead and support the implementation of soft-law initiatives and policy programs.

Detailed, systematic descriptions of action strategies used to support changes in large systems initiatives are still scarce. A multi-level approach is needed to fully grasp how ST is expressed in practice, as individual, group, and organizational-level ST are all inherent in a policy program. To increase the understanding of how to identify and learn more about the practical use of ST in policy programs and public health, we suggest further studies of how ST is used in practice in other policy programs, both in similar and different national contexts. The framework of the organizational ST principles used in this study, together with our observations of the interrelationships between different levels and dimensions of ST in practice, can contribute to such studies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study was reviewed by the Regional Ethical Review Board in Stockholm, and they found not to need for a formal ethical approval and issued a statement of this (Ref. No. 2018/620-31).

Author contributions

MN and HS designed the study and drafted the manuscript. MN, ST, and VS collected the data. MN, ST, VS, and HS conducted the analyses. All authors read, contributed to the article, and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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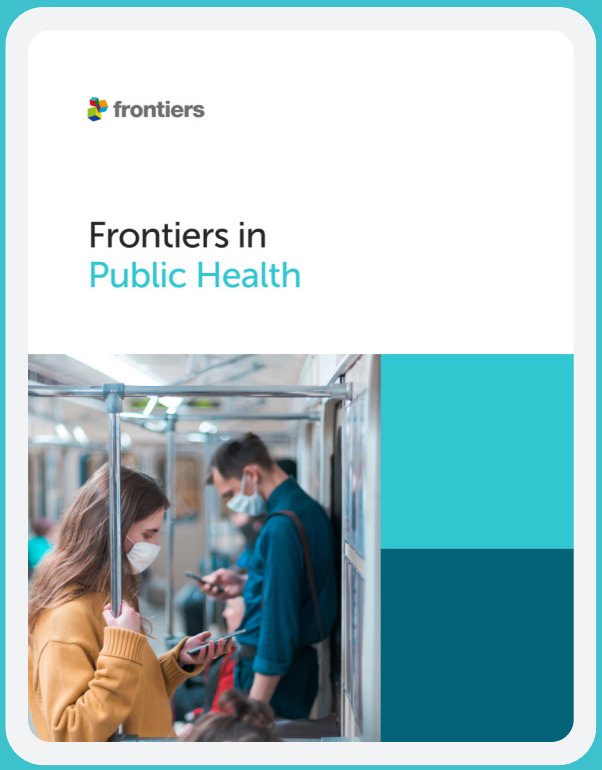

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