Local health systems resilience in managing the COVID-19 pandemic: lessons from Mexico

Running title: Local Health Systems facing COVID-19

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Key messages:

1. The preparedness of health personnel is key in the resilience of local health systems to face health crises and develop strategies to maintain the continuity in care.

2. The implementation of a variety of responses is necessary to address population needs and problems in different contexts, i.e., social violence, migratory movements, natural disasters, among others.

3. The main challenges occur at the local level, such as the need to devise strategies to adapt care and prevention of contagion risk using existing resources in rural areas.

4. The collaboration between local health systems and different social actors is essential for the emergence of a participatory governance that must include sustainability mechanisms.

Reflexivity statement:

The group of authors includes three females and five males. It comprises senior and junior researchers with diverse experiences in health research, focused on vulnerable populations in indigenous, rural, and urban contexts, or in the analysis of public policies of the Mexican health system, health services, sociocultural analysis and qualitative methods. Six of them have postgraduate degrees in public health in the fields of health systems or epidemiology, and two in Medical Anthropology.

Ethics approval

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Local health systems resilience in managing the COVID-19 pandemic: lessons from Mexico

ABSTRACT

The concept of *resilience* was applied to the public health field to investigate the way health systems are impacted by health crises, what conditions allow them to mitigate the blow, and how they reorganize once the crisis is over. In 2020, the COVID-19 pandemic caused by the SARS-CoV-2 virus represented a global challenge demanding immediate response to an unprecedented health crisis. Various voices drew attention to the intensity of the crisis in countries with greater inequalities, where the pandemic converged with other social emergencies. We documented the experiences of health personnel who faced the pandemic at the primary care level while simultaneously maintaining the functioning of other areas of medical care. Our results derived from a qualitative study comprising 103 participants from five states of Mexico. We aimed to show through inferential analysis their perspective on what we call "the resilience of local health systems." We observed three stages of experience during the crisis: (a) Preparation (official guidelines received to organize care, training, and planning of epidemiological surveillance); (b) Adaptation (performance of community-based prevention activities, infrastructure modifications, telehealth); (c) Learning (participatory governance with city councils, business sector, and organized population). The study suggests that the local health systems analyzed benefited from the initiatives of health personnel that in some cases positively exceeded their duties. In terms of the resilience analysis, they were able to handle the impact of the crisis and cope with it. Their transformative capacity came from the strategies implemented to adapt health services by managing institutional resources. Their experience represents a lesson on the strengthening of the essential functions of health systems and shows a way to address successfully the increasingly complex health challenges of the present and future times.

INTRODUCTION

Resilience is the ability of any material to recover its original shape or state after being subjected to deformation by an external force. In Psychology (Werner, 1989; Cyrulnik, 2001), this concept has been used metaphorically to study the processes whereby people who have endured extremely adverse experiences can return to their normal lives. The experiences lived by those people can be divided into three stages: Impact (a shock that causes a crisis), adaptation, and learning (Brand and Jax, 2007). The concept of resilience has been applied to the field of public health to study how health systems receive the shock of health crises, what conditions allow them to absorb the blow, and how they reorganize once the crisis is over; all this while maintaining the same characteristics of care provision (Giarelli, 2020; Davis, 2021). Though there are some variations in the definition of resilience within the public health field, it is generally understood as the ability of health actors, institutions, and the population to prepare and respond effectively to crises, while the health system maintains its essential care functions during the crisis and from the lessons learned reorganize itself to obtain favorable health results (Kruk et al., 2015).

In the public health context, the concept of resilience has been used to study some epidemics that emerged during the first two decades of the twenty-first century, namely severe acute respiratory syndrome (SARS), Ebola, and Zika, which tested health systems in some regions of the world and showed the fragility of some countries to cope with public health emergencies. In 2020, the COVID-19 pandemic caused by SARS-CoV-2 virus represented a global challenge that demanded immediate response to an unprecedented health crisis through public policies particular to each country according to its context and resources. In 2020, the World Health Organization (WHO) stated that "building resilience

is a key factor in promoting and protecting health and well-being at both the individual and community levels." (WHO, 2021). Highly effective strategies aimed at keeping the essential functions of health systems have been developed, mainly based on four components linked to the concept of resilience, which are (a) activation of governance mechanisms, (b) adaptation of existing resources both on health personnel and on medical products and technology, (c) offering of health services, and (d) actions on public health to reduce the vulnerability derived from infection risks (Haldane et al., 2021).

In 2005, the WHO established the International Health Regulations (IHR) as "a legal framework for the management of acute public health events of potential or actual national and international concern." (WHO, 2008) The IHR are pertinent as a tool to identify the strengths and weaknesses of a health system response to the COVID-19 pandemic. The IHR have been a reference for the development of evaluation proposals aimed to assess the capacity of health systems to prepare for and respond to health emergencies. One of these regulations is the resilience index, which consists of five requirements: (1) recognition of the strengths and weaknesses of the health system itself with respect to its population context, (2) diversity to respond effectively and with financial protection to the health needs of the population, (3) self-regulation to coordinate between services and adapt care models according to the moment of crisis, (4) integration with a governance approach to achieve social commitment, and (5) adaptation for an organized and timely response (Kruk et al., 2017).

Several authors, however, have pointed to the deeper crisis represented by the COVID-19 pandemic in countries with greater social inequalities, such as those in the Latin American region (Etienne et al., 2020; The Lancet, 2020). There, the pandemic converged with other

social emergencies, putting additional pressure to health systems to address complex health issues because of population dynamics, inadequate infrastructure, and diversity of epidemiological contexts.

Mexico has suffered the impact of the COVID-19 crisis with a high cost in human lives. The high prevalence of non-communicable diseases (NCDs) in the country has caused a syndemic rather than a pandemic (Hernández, 2020). From the beginning of the pandemic up to April 2022, more than 400,000 deaths and more than 5 million cumulative cases had been reported, with a mortality rate of 2.2 deaths per thousand inhabitants (National Institute of Public Health, 2022). Furthermore, the percentage increase in total deaths (compared with the average of 2015-2019) represented more than 50% of excess mortality, the highest among the countries from the Organization for Economic Co-operation and Development (OECD, 2021). In Latin America and the Caribbean Region, the case-fatality rate has been averaged at 3.4%, whereas Mexico has reported a lethality of 16.6% (Schwalb et al., 2022).

The emerging response had to be activated from a fragmented health system model in a country with 126 million inhabitants in conditions of socioeconomic disparity. In Mexico's public health system, the population affiliated to social security, represented by formal workers and their families, receive health care services without restriction, funded by employers, employees, and the government. On the other hand, the population without this benefit, who constitute almost half of the population with lower income, are served by state and federal government institutions or must resort to private services and bear out-of-pocket expenses (Shamah et al., 2020). In this context, since the beginning of the COVID-19 pandemic, the Ministry of Health implemented response strategies, which were adapted

throughout 2020 and 2021, and based on scientific evidence, international guidelines, and weekly epidemiological information on national cases and deaths. Yet, flaws in the decision-making process and in the model for emergency management have been documented, such as inaccuracies of the surveillance system and low rates of proactive testing, case identification, and contact tracing (Institute for Global Health Sciences, 2021).

One of the main objectives stated in the COVID-19 response guidelines of the public health system was not to exceed the hospital capacity for the care of cases, given the serious difficulties represented by weak infrastructure and a lack of health personnel. This situation worsened in public services for the population without social security—vulnerable in economic and demographic terms—, mainly for residents of marginalized rural communities. In a centralized context of public health policies, the State Health Services (SHS), responsible in each of the 32 states of the country for the care of this population, but with little decision-making capacity to participate in the planning of health programs, implemented the guidelines established at the federal level. Nevertheless, they designed some local care strategies to address the needs of the population with fewer resources. In this context, health personnel carried out prevention activities, detected and cared for cases of COVID-19, and at the same time kept essential health services working, which represented a great challenge.

Health personnel are the backbone of health systems and are key to achieve service delivery, yet there is a knowledge gap on how they coped with the pandemic while performing at the same time their daily work. This article presents partial results of an extensive study aimed to recover the experience of different types of health personnel who faced the challenge of providing community and ambulatory care during the COVID-19

health crisis. Here we present only findings on the "resilience" category that emerged from the data inferential analysis. We are interested in contributing to the debate proposed by Saulnier (Saulnier et al., 2021) about the need to build a research agenda on the resilience of post-pandemic health systems, recovering evidence on how the impact of crises is absorbed at the microsocial level, and health systems adapt and transform.

MATERIAL AND METHODS

Study design and population. This is a qualitative, exploratory study (Denzin and Lincoln, 2011).

For this study, a "local health system" is understood as a health-focused organization of the state government working within a territorial delimitation (states) with its own health service infrastructure and organizational structure. In Mexico, this structure is divided into Health Jurisdictions (HJs), which are technical-administrative departments varying in complexity; they are responsible for the operation of health care programs at district level. A HJ can territorially group one or several municipalities in rural and urban areas. The local health system also manages regulations for the provision of public and private health services. It coordinates and allocates health resources for their best use, which are own resources—human, material, financial, information systems—and those coming from the federation.

Initially, seven states from Northern, Central, and Southern Mexico were selected because of their diversity of social, environmental, and populational contexts (border, sea, and mountain regions, including migrant population, indigenous population, and itinerant day laborers). Of these, five states agreed to participate in the study, two in the North region,

one in the Southeast region, one in the Gulf of Mexico, and one in the Yucatan Peninsula

(National Institute of Statistics, Geography, and Informatics, 2021). Afterward, a sample of

different types of health personnel who worked in public health services and provided care

to population not affiliated to social security was selected.

(Insert Figure 1)

Sample selection. SHS management was contacted to explain to them the objectives of the

study and the interest of analyzing a variety of health personnel's experiences in both urban

and rural areas. Data from the states were reviewed and three HJs from each state were

chosen for a total of 15 HJs. Next, a purposive sample of state managers and health workers

responsible for HJs was chosen. Likewise, medical units of ambulatory care were selected

in rural and urban areas (39 in total; urban area 21, rural 18). In these medical units,

different types of health personnel were chosen to have sufficient variety of viewpoints

regarding the care provided to the population during the health emergency. The main

inclusion criterion was to be a health worker performing community activities focused on

prevention of COVID-19 infection risk, detection of cases (COVID-19 home screening),

remote care for uncomplicated cases staying at home, and referral of complicated cases to

designated hospitals. The sample totaled 103 participants and consisted of health managers,

medical staff (responsible for clinical care), nursing personnel (in charge of preventive

actions), and health promoters (who carried out community-based health promotion).

(Table 1).

(Insert Table 1)

Data collection and instrumentation. Data were collected between December 2020 and August 2021. The main technique used to gather information was the semi-structured qualitative interview. Guides were elaborated by type of health worker (health managers, medical personnel, nursing personnel, health promoters), designation (HJs, community health brigades, health centers), and interviewees' place of work (rural or urban area). The guides were organized into two thematic axes. The first axis explored aspects of the reorganization of health care services from the start of the pandemic and included the following topics: coordination for medical care, infrastructure adaptations, prevention activities to avoid the risk of COVID-19 infection, referral of cases, protection equipment for health personnel (masks, sanitation measures), support for health personnel, human resources situation, and coordination with other government and civil society sectors to address the pandemic. The second axis explored barriers and challenges to face the pandemic and was disaggregated into the following themes: continuity of priority health care programs (immunization for children under 5 years of age, care for chronic diseases, reproductive health), challenges for care during the pandemic, and recommendations to keep coping with the pandemic.

All interviews were conducted by video calls due to sanitary restrictions in the states to carry out face-to-face activities. This facilitated the access to very remote rural areas that under normal conditions are difficult to reach, though there were also connectivity limitations. The interviews lasted on average 30 to 90 minutes; all of them were audio-recorded and transcribed verbatim.

Data analysis. The perspective of the Constructivist Grounded Theory was used for the analysis of the data (Charmaz, 2006). From the interview guides, first, two types of information concentrates were elaborated according to the thematic axes, i.e., by

interviewee's type of health work and by topic explored. Later, content analysis of the interview transcripts was performed manually. The transcripts were coded by analyzing line by line (Glaser and Strauss, 1967; Strauss and Corbin, 1997). Six categories (initial codes) were constructed, from which 19 sub-categories (focused coding) derived (See description of each thematic category in code tree SM-1). Subsequently, the interconnections between the codes were analyzed to construct categories that grouped the experiences narrated by the interviewees according to the coincidences between the situations. In this way, the theoretical category "resilience" was constructed, which analyzes the capacity of the interviewed health care actors to prepare, adapt, and respond in a coordinated manner to the challenge of prevention and care for cases of SARS-Cov-2. This category consisted of three codes (theoretical codes): Preparation for the health crisis; Adaptation and Management of the pandemic; and Learning, to which some of the above subcategories were integrated (See description of each thematic category in code tree SM-2).

Ethical aspects: The interviews were conducted after prior verbal informed consent. The principles of research ethics stated in the Declaration of Helsinki (World Medical Association, 2013) were followed. As this is a sensitive matter, the names of the states and villages where the fieldwork was carried out and of the health personnel who agreed to be interviewed have been removed.

RESULTS

The health crisis has not ended. As of the time of closing our study, adjustments were still being made to deal with the pandemic. The health personnel interviewed had the experience of the first wave of infections and the beginning of the second. It has been a heterogeneous

learning process that overlaps according to the context of their place of work (rural or urban) and the human and material resources available.

We organized the results of the study into three stages: Preparation, Adaptation, and Learning. Tables 2 and 3 show in more detail how the pandemic was addressed and how the situations presented in the rural and urban scenarios were solved, according to the level of responsibility of the actors interviewed. Figure 2 illustrates the dynamic interaction between the three stages, i.e., the circumstances of uncertainty, disruptions, and feedback through the flow and movement of the system.

(a) *Preparation for the health crisis*

The HJs are organized as follows: the care areas and the number of health staff working in each medical unit of primary care level depend on the population served in a determined territory and the size of the unit. In rural units, there is a single basic nucleus (BN) consisting of a doctor and one or two nurses. In urban units, in cities with a large population, the medical services consist of three and up to 14 NB. Additionally, they may have personnel of health promotion, nutrition, dentistry, psychology, or laboratory services, including social service staff for each of these care areas, distributed at different working hours. This is important to note because the planning of services at the managerial level responded to the needs of health personnel in those terms.

(i) The process followed: For explanatory purposes, we defined three stages of preparation according to the narrative of the interviewees at the managerial level to show a part of the process followed. In practice, however, these stages overlapped since the emergency response measures were not taken in all the states at the same time. *First stage:* It was

characterized by surprise once the national epidemiological system gave the alert. The states began designing local guidelines to organize care using the existing scientific evidence, but there was no glimpse of what the impact of the virus might be. This occurred around the world during the first months of the pandemic. *Second stage:* From the arrival of the first case to Mexico and the increase in infections, the pandemic was formally recognized in the country. In the states, training for teams of health professionals was intensified, preventive measures were disseminated to the population, and medical facilities were prepared. Actions diversified as more evidence-based information was available. *Third stage:* It began in March 2020, when severe cases and deaths from COVID-19 increased. The situation led to lockdown (closure of non-essential economic activities and schools) and made medical care more difficult.

(ii) Training: The strategy for the training of medical and nursing personnel, as well as health promoters was developed in three directions. They received permanent virtual training through videoconferences on (a) recognition of warning signs to detect symptoms and cases, handling of the disease, and follow-up and referral of cases to hospital; (b) adaptation of infrastructure of medical units to prevent infections; and (c) organization of health personnel under their charge to carry out community preventive measures and show them how to use personal protective equipment, such as face shields, masks, gloves, and goggles.

(iii) Planning for epidemiological surveillance: States with virtual platforms for epidemiological registration adapted them for the control of COVID-19 cases (State 4); otherwise, they used paper formats and reported via telephone or email (State 2). In both circumstances, responsibilities were appointed to report results daily more efficiently at national level. Call centers were established; staff were assigned to answer calls and guide

people on identification of symptoms and referral to hospitals (State 1, State 3). In all states, mobile health teams were set up to take samples. At the state level, health promoters were assigned to integrate community COVID-19 screening teams during the stage when more infections were detected.

(Insert Table 2)

(b) *Adoption of measures and adaptation against adversity: "making more with less"*

(i) Supplies for care. At the start of the pandemic, one of the biggest concerns of health personnel was protection from infection. During the first few months, personal protective equipment (PPE) was slow to reach medical units, especially in rural areas. Health personnel reported using their own resources to buy PPE and disinfectant products. Later, PPE was supplied from the state level. For nursing personnel and health promoters, the equipment received consisted of masks and disinfectant products. Doctors, due to close contact with patients, received gowns, goggles, or face shields. As cases increased, more PPE was needed, and shortage occurred in rural areas. Health personnel spent their own money to buy more protective equipment, such as three-layer masks.

(ii) Community prevention activities for COVID-19. Several actions were carried out depending on the stage of the pandemic. As a first action, educational material was prepared and information on how to prevent infection (handwashing, use of masks and alcoholic gel) was distributed. Health teams were integrated to give prevention information in key places, such as markets, schools, shopping centers, and transport hubs. Social networks were also used for dissemination of information on the pandemic. With the increase in cases, other strategies were added. COVID-19 screening stations were installed

at state and municipal borders and in bus stations and airports; test samples were taken in some places. After lockdown, health teams reduced the number of prevention activities to avoid infection. In some medical units these activities continued only inside the facilities. The role of health promoters and nursing personnel was key to COVID-19 prevention and care activities in urban and rural areas. Overall, preventive activities were carried out in urban areas without great difficulty. In rural areas, however, where most of the medical units are small and have few health personnel, the prevention actions underwent some adjustments. For example, administrative staff had to participate in some units. In states with indigenous population, nurses who spoke the indigenous language distributed prevention information. Also, some states prepared educational materials on prevention measures in indigenous languages. In the northern states of the country, prevention work extended to the migrant population, agricultural day laborers, and textile factory workers.

(iii) Care of COVID-19 cases in outpatient medical units. Once training was received, infrastructure adaptation in medical facilities was the following step. Screening stations were set up to measure body temperature and provide hand sanitizer to each person upon entering the facilities. Entry and exit routes were drawn and spaces were marked to maintain the appropriate distance. The medical units that were able to, allocated an exclusive office for the detection of COVID-19 cases and adapted spaces for the taking of PCR tests. All available spaces were used, and some administrative offices were transformed into consultation rooms. In rural areas, warehouses for cleaning supplies were used by heath workers as dressing rooms and places to sanitize themselves; patios became waiting rooms.

COVID-19 management followed a three-step process depending on the stage of the pandemic: (1) The medical unit informed patients of positive COVID-19 results. The

nursing personnel recommended home care measures to both infected persons and their families. Patients were to be isolated at home and symptoms were monitored via telephone; when necessary, patients were referred to hospital. (2) With the increase in cases, mobile teams were integrated to search for COVID-19 cases; the work of nursing personnel and promoters was essential due to their acquaintance of the population. (3) The states with the greatest human resources (State 4) extended the work of the mobile teams (health brigades) to carry out home visits, assess possible cases, take samples with the aid of epidemiological teams, and prepare censuses. The positive cases were given information for home care; some of them received an aid kit including an oximeter that later had to be handed back to the health personnel.

Some states allocated ambulatory care facilities of greater capacity as "COVID centers" to exclusively perform diagnostic tests on suspected cases, inform on results, monitor positive cases at home via telephone, and give information for referral to hospital. Other states reassigned health workers from other care departments to cover services lacking staff, who were in leave because of occupational risks. In rural areas, some medical units temporarily closed while staff infected with COVID-19 recovered or substitutes were sent.

(Insert Table 3)

(iv) Medical care for other diseases. Owing to the lockdown and the limited access of non-urgent cases to medical facilities, continuous care delivery was challenging, mainly for population needing regular care or supplies, such as pregnant women, children under five years of age in need of immunization, patients with pulmonary tuberculosis, and people with chronic diseases. These cases were monitored remotely by telephone and social media

platforms. An example is the follow-up of patients with chronic diseases. Self-monitoring patients with hypertension or diabetes were followed remotely (telephone messages); when necessary, home appointments were made, and medicine supplies for up to three months were sent over to them. Other relevant aspect of the participation of health personnel was the continuation of preventive programs, such as vector eradication campaigns and health promotion activities. In the voice of an interviewee:

> *"[The priority health programs] continued to work, but the health promoters had to work harder. The period of dengue transmission came, and they worked a lot on that, both on the vector program and on the promotion program [on COVID-19 prevention], house by house and in the neighborhoods. And during the influenza period, they promoted vaccination"* (HJs level, State 1).

One of the main problems for continuation of care delivery mentioned by health staff in both urban and rural areas was the fear of people to return to health units because of the risk of infection. This had a negative impact on care for chronic diseases, immunization of children, and prenatal control. Likewise, one of the main challenges to get patients back to health units will be to fight against self-medication and use of home remedies to relieve symptoms of non-COVID-19 diseases.

(v) Difficulties faced by the health personnel. Some interviewees talked about some circumstances that hindered the planned care process. In rural areas, mainly those with indigenous population, persons infected with COVID-19 and their families did not inform health personnel about their condition for fear of being discriminated and attacked by other members of their community. In State 4, a border state in Southern Mexico and a region of abundant rivers and jungles, health teams make visits to villages in boats. There, unforeseen

technical troubles delayed the COVID-19 screening of population. On the other hand, northern border states deal with the flows of migrant population that camp in humanitarian shelters. In addition, people who work in the United States and have family in Mexico returned to the country during the closure of the borders and were identified by health personnel as the origin of outbreaks in small towns. Another example is the reluctance of the population to adopt protective measures. Moreover, health workers experienced violent reactions of people due to fake news about the origin of the pandemic; this occurred in both urban and rural areas. These circumstances hindered the early detection of symptoms, care, and follow-up of contacts of infected persons, and led to the readjustment of some strategies, such as the escorting of health personnel by local authorities for protection.

(c) *Learnings*

(i) Collaboration with authorities. Local authorities helped health personnel by installing screening stations and providing information on prevention measures to the population. In rural areas, the authorities collaborated with health personnel by keeping non-essential activities closed, escorted them for protection during COVID-19 informative visits to potentially dangerous areas, and collaborated by persuading infected people to stay in their homes. They also asked the population to avoid massive parties and crowds and recommended the suspension of religious services. In indigenous communities, traditional authorities supported health workers by persuading people to practice sanitary measures.

(ii) Donations. In rural areas, local municipalities donated protective equipment, disinfectant products, and cleaning equipment. Some mayors (State 5) distributed to health staff personal protective equipment donated by ordinary people and civil society organizations. In other states, the union of health workers collaborated. Oxygen tanks and oximeters were also obtained, which were borrowed to COVID-19 patients keeping

quarantine in their homes. Some health centers received donations to cover open spaces where they moved waiting rooms and vaccination stations.

(iii) Cooperation links for the management of the pandemic: The interviewees reported the collaboration of business associations that helped by replicating risk prevention measures inside factories. In states with migrant population, government agencies supported health workers in preventive activities focused on this mobile population. Health personnel partnered with state government departments responsible for health and educational institutions, as well as with hospital management departments, the Red Cross, and some laboratories. According to the context of each state, the Armed Forces and the Navy helped to coordinate activities. Coordination was also established with municipal authorities to use official ambulances for transfer of COVID-19 patients.

(iv) Participation of the population. Nurses and health promoters were assisted by local residents and neighborhood networks. Especially in rural areas, the voluntarily aid by people from different communities contributed to maintaining communication with the population. The interviewees highlighted their experiences with neighborhood committees that supported them in various activities, and with youth brigades, which helped disseminating messages using telephone chats. Additionally, voluntary women were trained as screening assistants. In indigenous populations, local leaders contributed by translating prevention information. Among other examples, the experience of two states stands out, as they suffered natural disasters caused by hurricanes at the same time as the pandemic was unfolding. There, neighbors participated organizing shelters to house people infected with COVID-19.

(v) Dynamic interactions in health systems

Figure 2 shows, from the perspective of complex adaptive systems, the dynamics and

interdependence interactions that were built between the three stages analyzed. In the

Preparation phase, links were established with preventive medical services to develop care

guidelines, train human resources, plan preventive measures, and obtain personal protective

equipment. The Uncertainties stage, which is part of the unpredictability of complex

systems, was characterized by the increase of challenges to manage infection risk

prevention and provide medical care. This generated disruptions in the feedback of the

various teams of human resources that participated in the response to the health crisis.

Between the Preparation phase and the Uncertainties phase, there were moments of

disruption caused by the different needs, contexts, and social responses to compliance with

health measures in rural vs. urban areas, which hindered the work of the health teams. In

the Adaptation stage, the assimilation of previous experiences and the use of mobile

communication technologies for case monitoring and remote care stand out. Finally, the

Learning stage incorporated the experiences of local health systems and the interactions

promoted by social intermediaries for the management of the health crisis.

(Insert Figure 2)

DISCUSSION

According to the WHO, understanding how resilience is built in health systems is a key

factor in promoting and protecting health (WHO, 2021). Nevertheless, as Saulnier remarks,

a lot has been talked about resilience in conceptual terms, but little is shown in a practical

way on how it is built on a day-to-day basis, which is essential for health system recovery

in the post-pandemic era. The findings of this study offer a view of how decisions are made daily, both at the managerial planning level and at the health personnel level, in prevention and care activities. It was the social actors interviewed who built the resilience of the local health systems. From this approach, as the authors above mentioned point out, it is necessary to understand that resilience is simultaneously a *result* and a *skill*, both aspects occurring at the same time and feedbacking each other. This idea broadens the classic definition of resilience that equates it with health system efficiency. Analyzed from a complex systems approach, resilience should thus be understood as a process that enhances the experience of the health system through the interconnections generated at different participant levels, which facilitates the planning of more focused responses.

In the stage of Preparedness for the health crisis, local actions were organized as part of the strategies implemented by the Mexican health system for the response to the pandemic before vaccine availability. Actions included containment and mitigation of infections through home confinement, closure of non-essential school and work activities, general hygiene measures, and adaptation or conversion of services for the care of cases (Martínez et al., 2022; Mendoza and Suárez, 2020). The centralized governance also defined national policies, which narrowed the response according to regional and local needs (Díaz et al., 2021; Knaul et al., 2021).

The training of health personnel was the main action carried out during this stage. At the same time, other components of the health system influenced the preparedness for service delivery, but it was the conditions of the context that exerted the greatest influence, with rural areas facing additional challenges. This situation has been reported as well in other countries (Schiff et al., 2020, Peters, 2020, Vázquez and Gandolfi, 2020, Bastos and

Fonseca, 2021) that paid less attention to rural areas during the COVID-19 pandemic, to territories inhabited by indigenous population, and to homeless people with fewer social resources and greater susceptibility to COVID-19 infection. The inadequate protection for these population sectors has already been evidenced from the public policy analysis (Lal et al., 2021) as one of the serious pending tasks in the response to the pandemic.

The priority for resource allocation in case of a health emergency has also been analyzed (Senthilingam, 2021, Schiff et al., 2020, O'Sullivan et al., 2020, Etienne et al., 2020). Urban areas represent a greater risk of virus transmission compared with rural areas due to the higher population density of the former. Rural areas, however, present other challenges, such as the difficulty in accessing health services, a situation of structural inequality aggravated by the COVID-19 pandemic.

During the Adaptation stage, and in relation to *skill*, another aspect to consider was the effort of health professionals to reach small villages in remote areas and provide care in conditions of great disadvantage, such as personnel shortage and high demand for care. This enormous effort had costs to their physical and mental health, which has been reported in other contexts as well (Galbraith et al., 2021, Vizheh et al., 2020, Walton, Murray, and D Christian, 2020, O'Sullivan et al., 2020). In Mexico, as in other Latin American countries, the reassignment of personnel to address the health emergency caused a lag in other health services, such as care for NCDs (OPS, 2020). To counter that situation, health personnel was temporally hired, and other strategies were developed, such as greater provision of medication to control chronic illnesses at home (Colchero et al., 2021; Martínez and Gómez, 2022; Tetelboin, Iturrieta and Schor, 2021).

As for learning, the pandemic demonstrated the capacity of health personnel to self-manage (which also refers to *skill*) in the performance of preventive activities (an area of special relevance for the containment of the pandemic), in the solution of challenges represented by the remote monitoring of people infected with COVID-19, and in the efforts made to give continuity to care for other diseases. In these activities, the use of technologies, specifically the mobile phone, was paramount. The emergence of electronic media as an alternative for care is also highlighted by other studies. The use of videoconferences to provide medical consultations and inform on preventive measures against the pandemic, the so-called "telehealth" (Bhaskar et al., 2020, Meyer et al., 2020; Monraz et al., 2021), is identified as an important aid to extend care coverage in rural areas.

Another learning in crisis management was the work of "social intermediaries", as Blanchet (Blanchet, et. al., 2017) calls them. These are actors that form links between users and "build bridges" with health services, provide greater local knowledge, and represent an opportunity to expand the provision of services. These organizational experiences arising spontaneously "from below" as a help offer from the population show the need for the re-conceptualization of the term "participatory governance" from the experience of the pandemic. They represent a way of integrating the decision-making spaces generated on a day-to-day basis with different social actors who usually were not considered in the traditional concept of governance, as they did not have a formal participation in the decision-making process (Pyone, Smith and van den Broek, 2017, Kickbusch and Gleicher, 2012). It is important not to lose these initiatives by setting up mechanisms to integrate them.

CONCLUSIONS

The local health services analyzed in this study benefited from the initiatives of health personnel that in some cases positively exceeded their duties. In terms of the resilience analysis, their effort was key in the ability to handle the impact of the crisis and cope with it; their capacity came from their strategies to adapt health services by managing the resources available. From this perspective, our study shows the need to set up response plans for public health emergencies that allow implementing timely and effective care strategies, considering the diversity of contexts as well as the social actors that activate local support networks. The case of Mexico illustrates the way local health services responded effectively to care demand generated by the COVID-19 pandemic making do with the existing infrastructure, personnel, and supplies, in coordination with communities. Yet, the limitation of resources and the heterogeneity of the responses of each region according to its capacity resulted in the delayed care of other pressing health conditions. The results of this study point thus to the need for the implementation of public health policies that consider the health conditions of a population and the capacity of services specifically by region and local contexts as the basis to strengthen the essential functions of a health system to successfully face increasingly complex health challenges of the present and future times.

LIMITATIONS

The above analysis derived from the inference of health personnel's narratives obtained by interview, which portrays their own outlook. Our aim was to know how they coped with the pandemic from their local frontline as part of the Mexican health system; therefore, the results are not intended to be generalized. Also, the stages for the assessment of resilience overlapped and did not follow a linear process. They were not homogeneous; even within

the states there were variations because of very vast areas to cover and great population

diversity. The information about the beginning of the health crisis reached the states at

different moments, so there was not specifically a phase of Preparation to deal with the

impact/shock, as the crisis and the subsequent stages affected the states unevenly. Lastly, a

thorough analysis of the health system resilience would require information on details on

the public policy developed to deal with the pandemic, financial resources aimed at the

different levels of care and the different health care sectors, details on intersectoral

participation and consensus agreements, among others. These aspects exceeded the

objectives of the present study.

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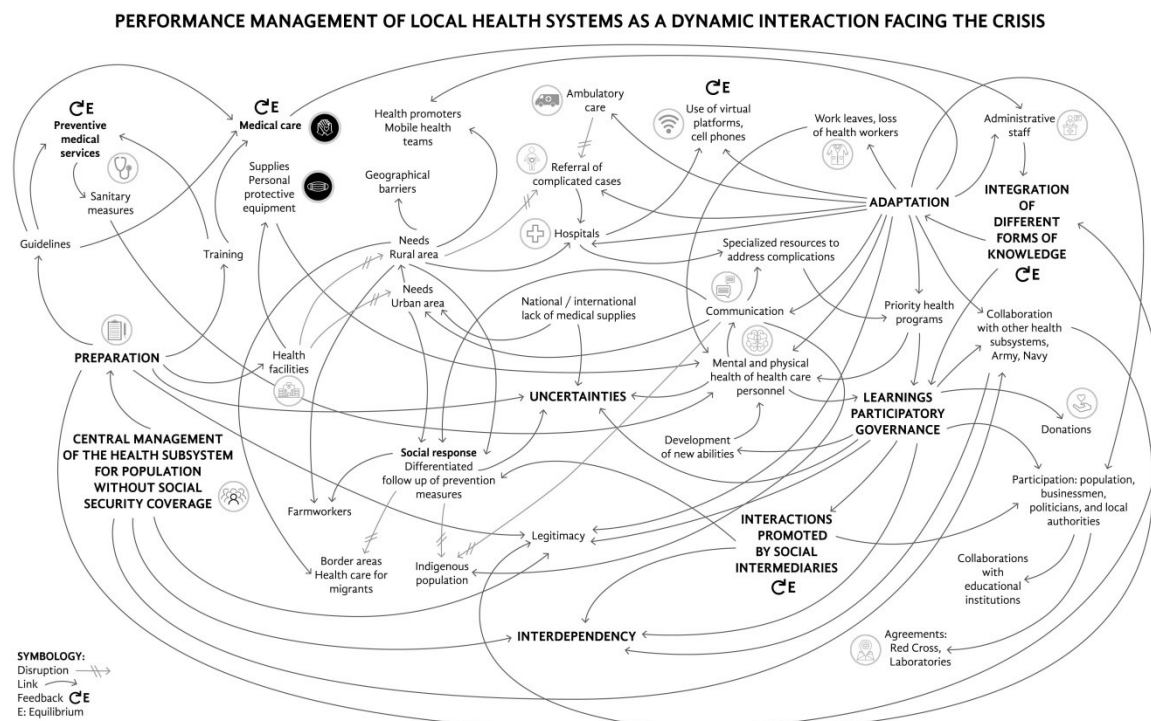
Figure 1

Figure 2

PERFORMANCE MANAGEMENT OF LOCAL HEALTH SYSTEMS AS A DYNAMIC INTERACTION FACING THE CRISIS

Table 1. Type of health personnel interviewed, working profile, and area of influence

URBAN AREA	State 1	State 2	State 3	State 4	State 5	Total
Health managers	5	4	3	9	4	25
Medical personnel	7	5	4	2	3	21
Nursing personnel	1	5	2	2	2	12
Promoters	1	7	1	5	*	14
RURAL AREA	**State 1**	**State 2**	**State 3**	**State 4**	**State 5**	
Medical personnel	1	2	4	4	5	16
Nursing personnel	*	*	5	4	2	11
Promoters	*	*	-	2	2	4
TOTAL	15	23	19	28	18	**103**

* **Source**: Own elaboration based on interviews according to rural or urban area.

Table 2. Relevant aspects of health personnel management in urban areas to respond coordinately to the impact of the pandemic, by type of health worker, area of influence, and examples of testimonies.

	URBAN AREAS

Explored topic / Type of health worker	How did they prepare for the pandemic?	How did they cope with the crisis?	Interinstitutional-civil society links and collaborations	EXAMPLES OF TESTIMONIES
Health managers	• They trained all health personnel in 'cascade' in issues of prevention and care of COVID-19 cases. The information changed as new scientific evidence became available. • They set up call centers to provide guidance on symptoms, testing sites, and referral hospitals. They designed health care centers solely for COVID cases and referral of complicated cases. • They organized epidemiological brigades to carry out home visits, take samples and follow up positive cases. • They installed modules to perform free COVID testing in urban medical units.	• The health teams included administrative staff, workers from the laboratory area, and medical, nursing and promoter staff. All participated in different tasks, making up for the lack of human resources in work leave due to COVID-related comorbidities or other illnesses.	• COVID-19 cases were treated by social security hospitals and hospitals set up just for COVID treatment. • Hospitals were adapted to receive only cases from remote areas. • A communication network was established between hospitals and reference centers for COVID cases from different institutions.	**How did they prepare?** [In medical units] *"We trained, and they trained all their staff... they followed up via telephone the cases that we were reporting to them; likewise, if they found a case... they sent us the data to the epidemiology area, and we filled out the epidemiological study of the case by telephone and assessed the sample taking."* (Woman epidemiologist 1, State 2) **How did they adapt?** *"... When transmission decreased a bit, we focused on the most vulnerable groups, over 65 and under 5 years old. We adopted some strategies... in cases of chronic patients, we chose to follow up via telephone and asked that some relative came for their medication ... especially those patients controlled... we gave them treatment for 2 or 3 months so that they would not have to come to the health units, thus protecting them..."* (Health manager, State 3) **Links and collaborations** *"... We were working with some non-governmental and government institutions to give all this type of information; we also had meetings with* [social security institutions], *the Armed Forces, and schoolteachers to do all this dissemination ... Also with a committee... an intersectoral committee where the Labor Secretariat and the Secretariat of Education participated... we have been very close to them to support them in these activities..."* (Health Manager, State 1)
Medical personnel	• They installed COVID modules for PCR sampling and rapid testing. • They made censuses of patients with	• They set up exclusive consultation rooms to see suspected cases. • They formed teams for home visits to	• Linking with social security institutions to refer COVID-19 cases. • Collaboration with local councils for ambulance use and transfer of patients with complications.	**How did they prepare?** *"Before the health emergency, they started training us because the epidemiologist was notified that an outbreak had started in Wuhan, China... She told us that we were preparing because we were facing an unknown virus, that we would continue doing our activities but*

	chronic diseases to have control of possible cases. • They planned to follow up positive cases and their contacts via telephone. • They made maps to identify areas with the highest concentration of positive cases. • They set up a call center to give information. • They implemented screening procedures. • Medical units in cities received more supplies.	pregnant women, children under five years old, and patients with chronic diseases. • They assembled teams to search for positive COVID-19 cases house by house. • Staff at risk obtained work leaves. • They increased hours of operation in medical facilities. • When necessary, they used their own economic resources.	• Integration of mobile teams for the dissemination of preventive measures.	*that we should stay aware. We hoped that this would not reach us here in Mexico..."* (Woman doctor, State 4) **How did they adapt?** *"We stopped seeing chronic degenerative patients; for them this was a risk. We were seeing them quarterly or every 6 months depending on how they were. We refilled prescriptions; if they were controlled their relatives came for medication and the nutritionists and social workers followed up patients by phone ... Also, pregnant women were scheduled for visits around every three months instead of having a monthly consultation and had an open appointment in case of any problem or any discomfort... Regarding the staff, there are 93-95 workers. We started working by guards, one day yes, one day not to avoid crowding of personnel... nurses, doctors, social workers, guards, promoters, administrators..."* (Doctor, State 1) **Links and collaborations** *"We have respiratory disease monitoring units... where you treat exclusively patients with respiratory symptoms. There I got contract staff, a doctor, a nurse, and a chemist ... Patients' samples are taken, and the epidemiologist is very attentive to all her patients... The complicated cases are referred to the hospital, upon request of an ambulance to the ambulance center because the health center does not have one..."* (Woman doctor, State 5).
Nursing personnel	• They received training and remained attentive to international information via T.V.	• They enabled spaces in courtyards as waiting rooms. • They took random samples. • They helped with epidemiologic	• Areas of influence were distributed by blocks in the colonies, and neighborhood committees were asked for support. They collaborated by disseminating information, even in indigenous	**How did they prepare?** *"We received training; then they asked us to replicate these topics both to patients and at the schools that at the time were still working."* (Woman nurse, State 5) **How did they adapt?** *"I was in the triage process when people are coming in. We receive*

	al surveillance. • They performed triage. • They gave COVID results. • They carried out preventive work. • They coordinated case transfers to hospitals. • They generated protocols to vaccinate children under 5 years of age.	languages.		*them and we take a speed reading and record their symptoms. Then I switched to screening, where you register people and ask them for information so they can see the doctor... I am currently in the giving of results; they gather the results on the platform, I am the one who tells you if you are positive or negative... Older adults, pregnant women go to consultation; they are given medicine and they are tested. In case they require it, they are sent to the hospital if they see them with advanced symptoms..."* (Woman nurse, State 3). **Links and collaborations** *"We had several WhatsApp groups of young people, pregnant women, patients with chronic degenerative diseases. We divided the community by ailments and affinities and by age groups. Those WhatsApp groups helped us to keep communication alive; they have been a great tool to keep the communication channel open ... We rely a lot on social media, Facebook, WhatsApp, radio, local TV channels, megaphoning equipment... We made agreements with the City Council, the Municipal Police, and they installed loudspeakers in the vehicles of the police and the Municipality and gave messages to the community... "* (Nurse, State 5)
Health promoters	• They were the last to receive training and they replicated it to the population. • They carried out information dissemination activities in schools before lockdown. • They received teaching materials for prevention activities. • When they were assaulted, they stopped wearing	• They used their acquaintance of locals to establish contact with the population and detect positive cases of COVID-19. • They made home visits to identify suspected cases. • They were linked to areas of Epidemiology. • They created mobile	• The health workers union supported with personal protective equipment. • City councils sent police to escort them in unsafe neighborhoods. • A pandemic reaction committee was formed with Chambers of Commerce. • Municipal presidencies agreed on actions such as closure of commercial areas. • Screening was implemented in shops.	**How did they prepare?** *"We started with training from the department; they told us about COVID-19 and the prevention measures so that we could later show them to our patients. By then we accepted patients in the waiting room and there I gave my talks on hand washing techniques, what the disease was like, and prevention measures."* (Woman health promoter, State 1). **How did they adapt?** *"... Poor nurses, at first not even the pharmacies let them in, not to talk of the businesses if they came in with their uniform. They had to recommend to the nursing staff that they arrive at their home and*

uniforms on the street. • They performed screening for COVID-19. • They disseminated information on preventive measures in public places, such as markets and bus terminals. • They appointed promoter coordinators to work with the same method in all medical units.	brigades. • They followed up positive cases in the call centers. • They followed up contacts of positive cases. • They adapted spaces in medical units with adequate distance for testing. • They informed the population of preventive measures. • They set up temporary consultation rooms for patients with suspected COVID-19. • They organized special days to care for pregnant women. • They treated patients with chronic diseases at home. • They used social networks to establish communications.	• Health committees were activated in the neighborhoods; the promoters asked them for support to disseminate information.	*change clothes* [to avoid aggressive behavior of the population.]″ (Woman health promoter, State 1). **Links and collaborations** *″Sixteen promoters hired by the Health Institute for Welfare were assigned...″* (Woman health promoter, State 4)

Source: Authors' elaboration from the collected data.

Table 3. Relevant aspects of health personnel management in rural areas to respond coordinately to the impact of the pandemic, by type of health worker, area of influence, and examples of testimonies.

	RURAL AREAS			
Explored topic	**How did they prepare for the pandemic?**	**How did they cope with the crisis?**	**Interinstitutional-civil society links and collaborations**	**EXAMPLES OF TESTIMONIES**
Type of health worker				
Medical personnel	• They received training in COVID-19 case identification and preventive measures. • As the pandemic intensified, medical personnel were also trained to take samples, as the demand surpassed the original sampling teams. • Administrative staff were trained to support. • They visited farmworker fields to inform on preventive measures. • They carried out dissemination of prevention measures massively and house by house.	• External waiting rooms and consultation rooms were adapted outside the medical facilities to avoid crowds and possible infections. • Patients were followed-up daily via telephone. • Severe cases were referred to the hospital. • Care was continued to be delivered to people in priority programs (pregnant women, children under five, persons with chronic conditions).	• They invested in their health, cooperating to buy disinfectant products. • Municipalities supported with supplies, reference of cases, risk prevention activities, and personal health protective equipment. • They held briefings with community leaders in small towns.	**How did they prepare?** *"You must take care of yourself; you have to invest in your health. We cooperated for the 'vaquita'; everyone donated, brought chlorine, soap, brooms, what everyone could donate at the time."* (Woman doctor, State 2). **How did they adapt?** *"We went hand in hand with the patients, getting to know the behavior of the disease with every patient. The follow up 24 hours a day gave us that. Whenever they wanted, they talked to us on the phone. Some who were not seriously ill went to the health unit for checking up; we had the commitment to help people, not to let them die."* (Woman doctor, State 2). **Links and collaborations** *"There is a Regulatory Operation Center that meets every 15 days or every week, depending on whether there is a change in the epidemiological traffic light. There meets the Secretariat of Health, the Municipality, the Armed Forces, the National System for the Integral Development of Families (DIF)... all institutions, and an analysis is made regarding which places need a prompt assignment of health services. A COVID line has been implemented to give information to people and here we have an institution that brought together groups of people to perform PCR tests in large chunks of the population. People were told whether the test was for monitoring, for symptoms, or if they had been in contact with COVID positive people."* (Doctor, State 1).

Nursing personnel			
• They were trained to adopt and teach prevention measures and detect signs and symptoms of the disease. They were updated whenever there was new evidence. • They informed on preventive measures and symptoms in the medical units, giving workshops, talks, by megaphoning and through social networks, chat groups, and telephone. • They promoted preventive measures among health personnel, such as hand washing, mask wearing, and use of face shields and goggles. • Those who spoke an indigenous language were responsible for disseminating prevention measures to indigenous population. • In shelters for migrants, they informed on prevention measures.	• COVID-19 cases were followed up using social media platforms and telephone. • Medical units with a single nurse could not do extramural prevention activities. • They cancelled non-urgent consultations. • They carried out disinfection work in the medical unit. • They avoided crowds by sending medication to chronic controlled patients for 1-3 months each time. • They separated consultation rooms. • They took turns receiving patients and providing information. • People who could get around were sent on their own to be tested for COVID-19. • They delivered positive COVID-19 results at home to give follow-up instructions to the family. • During the dissemination of preventive measures, families	• Linking with authorities to solve local problems related to COVID-19 outbreaks. • Local councils supported with protective equipment, disinfectant products, and cleaning equipment. Others provided human resources and ambulances. The councils obtained oxygen tanks and oximeters to lend to infected patients who were quarantined at home. They also banned public celebrations and religious services and closed non-essential services. • Linking with the local Red Cross to request ambulances for patient transfers.	**How did they prepare?** *"Later, with the personnel together with the promoters, it was requested that they replicated these topics, both to the patients and to the schools that at the time still worked."* (Woman nurse, State 1). **How did they adapt?** *"We are going to watch that it does not fall below 90, it has to be above 90. If you feel that you lack air lie face down, try not to make much effort. You must be isolated in your room, that there they bring you food. If you go out to the bathroom ... disinfect... Tell them to make an improvised atomizer with a bottle; put 1 liter of water and 10 ml of chlorine and every time you go out to the bathroom they will sanitize."* (Woman nurse, State 3). **Links and collaborations** *"Here... it is a place of a lot of traditions, of a lot of religion, so people did have a hard time stopping doing their festivities. And there we watched constantly that there were not many people together, who might get infected by COVID-19."* (Woman nurse, State 2).

		without resources were taught only the use of soap and water, not gel. • They coordinated transfers of complicated cases and found them place in nearby hospitals. • They took tests and sent them to laboratories at nearby hospitals or COVID-19 centers.		
Health promoters	• They received instructions from the federal and state levels to spread information about what was coming (leaflets, flyers, posters) They were then instructed not to leave out of medical health-care center. • They elaborated informative material in simple words that was disseminated in places of greater concentration of people. • They produced printed material in local languages. • Health personnel at risk were given work leaves. • Administrative staff were trained to support preventive measures activities. • They visited schools to promote prevention activities, such as hand washing and mask wearing. • They implemented screening procedures in the medical units. • They received	• They enabled spaces for sample taking. • They followed up positive cases by telephone to avoid contagion at home. • In localities with indigenous population, they convinced them to hold meetings wearing masks. • They recommended using temazcal baths to indigenous day laborers in the fields. • They recorded cases and reported to the epidemiology area.	• At the beginning, they bought face shields used for welding. • They activated youth brigades and neighborhood groups as support to disseminate sanitary measures and detect COVID-19 cases. • With Municipalities they closed non-essential services and helped to watch for compliance with lockdown. • They trained town officials. • They used social media to create chat groups and disseminate information.	**How did they prepare?** *"We bought our face shields; we even used the ones worn by the people who weld the iron; those are the face shields that we bought at first."* (Health promoter, State 5). **How did they adapt?** *"The patients were told that at all times, regardless of the hour of the day they could call us. In my case it was a plus... I had to take care of many of my patients in the early morning, I would tell them, 'Don't wait if you're oxygenating below 95, call me!' Why? Because we know that timely care is what has been making a difference."* (Health promoter, State 4). **Links and collaborations** "We *had altercations with the people; in the market they were fed up... that we gave them the information. They said that we only scared away the people who were going to buy their merchandise ... the health teams didn't want to go out anymore."* (Health promoter, State 2)

supplies and personal protective equipment. • When necessary, they bought personal protective equipment with their own resources.			

Source: Authors' elaboration from the collected data.