

# BMJ Open How has COVID-19 impacted the civil registration and vital statistics system in Loreto, Perú? Evidence using process mapping and qualitative analysis

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**To cite:** Silva-Valencia J, Adair T, Hart J, *et al.* How has COVID-19 impacted the civil registration and vital statistics system in Loreto, Perú? Evidence using process mapping and qualitative analysis. *BMJ Open* 2021;**11**:e055024. doi:10.1136/bmjopen-2021-055024

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-055024>).

Received 30 June 2021  
Accepted 03 November 2021



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## ABSTRACT

**Objectives** Accurate civil registration and vital statistics (CRVS) systems are the primary data source to measure the impact of the COVID-19 pandemic on mortality. This study assesses how the pandemic impacted CRVS system processes in Loreto region of Peru, one of the worst affected countries globally.

**Design** Qualitative study.

**Setting** Loreto, a remote region, which had the highest reported mortality rate in Peru during the pandemic.

**Participants** Semistructured individual interviews and documentary analysis were conducted between September 2020 and May 2021 with 28 key informants from eight institutions involved in death certification. Key informants were identified using a purposive sampling strategy commencing at the Health Directorate of Loreto, and the snowball method was used where a participant suggested another organisation or person. Information from key informants was used to compare business process maps of the CRVS system before and during the pandemic.

**Results** During early May 2020, there were seven times more registered deaths than in earlier years, but key informants believed this underestimated mortality by 20%–30%. During the pandemic, families had to interact with more institutions during the death certification process. Several issues disrupted death certification processes, including the burden of increased deaths, the Environmental Health Directorate often removing a body without the family's express agreement, the creation of COVID-19 cemeteries where no death certificate was needed for burial, greater participation of funeral homes that often used outdated paper forms, and closure of civil registry offices. There was increased use of the online National Death System (SINADEF) but many users had problems with access.

**Conclusions** The pandemic substantially disrupted CRVS processes in Loreto, making death certification more difficult, placing greater burden on the family and leading to more participation from unregulated organisations such as funeral homes or cemeteries. These disruptions were impacted by limitations of the CRVS system's processes before the pandemic.

## INTRODUCTION

The COVID-19 pandemic has caused an unprecedented impact on health systems

## Strengths and limitations of the study

- This is one of the first assessments of how the COVID-19 pandemic has impacted processes of the civil registration and vital statistics system, which should be the primary data source to measure excess mortality.
- The study was conducted in Loreto, the region with the highest reported mortality rate during the pandemic in Peru, one of the most adversely impacted countries globally.
- Key informants from several institutions involved in death certification were interviewed, providing a comprehensive description of how death certification processes were disrupted.
- The study, however, did not include the perspectives of families of the deceased.

globally. According to data from the WHO, 3.9 million deaths from COVID-19 had been reported worldwide by the end of June 2021.<sup>1</sup> However, this figure underestimates the true impact of the pandemic, with WHO estimating that excess mortality from the pandemic in 2020 to be two-thirds higher than reported COVID-19 deaths.<sup>2</sup> The primary source of accurate mortality data should be a timely and accurate civil registration and vital statistics (CRVS) system, which are a key input to inform important decisions in public health and generate adequate responses to humanitarian emergencies.<sup>3–8</sup> However, there is uncertainty about the true impact of the pandemic on mortality because of inherent weaknesses in CRVS systems in many countries, particularly low-income and middle-income countries. According to the United Nations, only two-thirds of countries register at least 90% of all deaths that occur.<sup>9 10</sup> Furthermore, in addition to the impact that the pandemic has had on all health processes, it has potentially weakened



already suboptimal CRVS systems and led many countries to produce unreliable data on mortality.

The COVID-19 pandemic has, therefore, emphasised the need to improve vital statistics and made it imperative that each country focuses on ensuring all the necessary processes for their CRVS system to effectively register deaths. Because CRVS systems are complex, with many actors and intervening components that depend not only on the health system but also other institutions, the first step for their improvement is to carry out a mapping of processes that can help capture the complexity in CRVS systems, including the main actors and processes. There have been factors that may have significantly altered information flows and mortality recording processes to the detriment of the quality of data in CRVS systems, such as measures related to compulsory social isolation, limitation of mobility, suspension of work and increased use of online platforms; evidence of such detrimental impacts has been found in several countries.<sup>11 12</sup>

Peru has been one of the worst affected countries during the COVID-19 pandemic. The first confirmed case was notified on 6 March 2020, and the first death occurred 13 days later. The exponential increase in infections began in the city of Lima (capital of Peru); however, by 12 April 2020, cases had already been reported in all regions of the country. By May 2021, Peru ranked first worldwide in total estimated excess deaths and is the only country that exceeded the historical average forecast by more than 100% compared with recent years.<sup>13 14</sup> Mortality data in Peru are mainly found in two systems: The National Death System (SINADEF), which is administered by the Ministry of Health (MINSA) and is where medical death certificates are registered; and the National System of Identification and Registry of Civil Status (RENIEC) that issues death certificates with official value to carry out legal procedures. The completeness of this death registry has increased over the years, reaching approximately 80% of estimated deaths since 2016, but with further scope for improvement.<sup>15</sup> A major explanation for incomplete data is lack of supervision of death certificate data collection. National regulations stipulate that for registration of paper medical death certificates, doctors should the certificate in two to deliver the upper part to the family members and to keep the lower part to deliver it to a dependency of MINSA (Loreto Health Directorate (DIRESA), Regional Health Management (GERESA) or Directorate of Integrated Health Networks (DIRIS)) for the data to be incorporated into SINADEF. However, many doctors give the family member the complete form without sending this information to MINSA, and the death is not registered in SINADEF.<sup>15</sup>

It may be that the COVID-19 pandemic has had a significant impact on the operation of the entire death registration system in Peru. During 2020, there were many factors that could potentially have altered how death registration processes are meant to operate as specified by existing regulations.<sup>16 17</sup> These include the strict national quarantine of more than 100 days, the limited availability of

doctors to produce timely medical death certificates due to the overwhelming demand for health services, deaths from COVID-19 in public spaces and new regulations for the handling of bodies, burials without documentation, among others.<sup>18-21</sup>

For the government at the national and local level to track and respond to the pandemic, it must have accurate information on mortality. Measurement of excess mortality in a hard-hit country such as Peru with already suboptimal death registration is reliant on assumptions of whether completeness of registration was negatively or positively affected by the pandemic, or remained unchanged.<sup>22 23</sup> Additionally, governments need to specifically know of the barriers to proper death notification and registration processes and how they can be rectified. To address the significant knowledge gap on this issue, this study evaluates how the COVID-19 pandemic impacted the civil registration processes and the mortality registry in Loreto region, one of the regions in Peru most affected by COVID-19. Specifically, the study's purpose is to describe how the death certification processes and the flow of information of the CRVS system changed during the COVID-19 pandemic.

## METHODS

### Setting

Loreto is one of the 24 regions in Perú. It is located in the more remote jungle area of Perú and represents 28% of the surface of the national territory with approximately 1.07 million inhabitants of Peru's population of 32.51 million. It is characterised by its great cultural diversity and the sparseness of its population, many of whom live in remote areas. As in many parts of the country, there is poor internet connectivity both in communities and in health facilities.<sup>24</sup> It was one of the worst affected regions during the COVID-19 pandemic; during April and June, it was the region with the highest reported mortality rate and the second-highest mortality of health professionals.<sup>25 26</sup>

Loreto registered his first official case on 17 March 2020, and his first death on 30 March 2020. During the first month of quarantine, the large number of SARS-CoV-2 infections destabilised the health system. It has been reported that the lack of protocols, the lack of personal protective equipment and the lack of oxygen aggravated the public health crisis in that region.<sup>27</sup> Among the preliminary studies that have been carried out in the region, the seroprevalence studies stand out, with it being reported that until 6 June, 58.3% of the health workers of the Regional Hospital of Loreto and 54.5% of the students present were positive for COVID-19.<sup>28</sup> Also, on 18 July 2020, a community seroprevalence study was published where it was found that 7 out of 10 inhabitants of the capital Loreto had already contracted the COVID-19 virus.<sup>29</sup>

### Study design

We conducted a qualitative case study using semistructured individual interviews and documentary analysis

**Table 1** Organisations participating in the study

Name	Brief description	Location
Ministry of Health	Governing body on health at the national level	City of Lima
Directorate of Health (DIRESA) of Loreto	Governing body of health at the regional level	City of Iquitos, Loreto
Office of Statistics of DIRESA Loreto	Office in charge of generating statistics of the National System of Deaths	City of Iquitos, Loreto
Offices of Epidemiology (CDC)	Offices of the National Center for Epidemiology, Prevention, and Disease Control (CDC)	Urban and rural areas of Loreto
First Level Health Facility	Primary care health centre that serves the community and can refer cases to hospitals	Rural area of Loreto
Regional (National) Hospital of Loreto	National Hospital funded by the Comprehensive Health Insurance.	City of Iquitos, Loreto
Hospital EsSalud	Workers' hospital financed by Social Security	City of Iquitos, Loreto
Funeral Homes	Company that at the request of the relatives is responsible for the final disposal of the body of the deceased	Urban and rural areas of Loreto

with key informants within the institutions involved in death certification in Loreto, Peru, between April and August 2020. We then used the information collected to compare business process maps during the pandemic to before the pandemic.

### Sampling and recruitment

We used a purposive sampling strategy to identify key informants from the institutions involved in death certification in Loreto, Peru, during the study period. To commence the study, we travelled to Iquitos, capital city of Loreto, and the Health Directorate of Loreto was consulted. There, the snowball method was used, where the participant could suggest another organisation or person to complete and/or enrich the information. The person in charge, official, technical team or best available user who was involved in the death certification process during the study period was considered a key informant. Then, a contact list was drawn up and a member of the research team scheduled face-to-face and virtual meetings to carry out the interviews and/or request documentation, after explaining the study to the possible participants.

Our sample consisted of 28 participants from the following organisations: MINSA, Directorate of Health of Loreto, Office of Statistics, Office of Epidemiology, First Level Health Establishment, Rapid Response Team for COVID-19, Regional Hospital of Iquitos, Hospital EsSalud de Iquitos and Funeral Homes (table 1). The stakeholders interviewed included very senior staff such as a managing director or executive director of the institution, technical staff including from the IT technical team and physicians. We were unable to recruit participants from official and unofficial cemeteries.

### Data collection

We conducted a series of semistructured interviews between September 2020 and May 2021. We developed questions based on the enterprise architecture methodology and feedback from the research team. The

questions included inquiries to understand changes in processes and information flows in a pandemic context, as well as the impact of these possible changes on the effectiveness of death certification. The interviews were conducted by telephone, videoconference and in person and lasted were of 30 to 45 minutes duration. The units of analysis included the transcripts and field notes taken by the research team during the interviews. Informed consent was obtained verbally from all participants prior to the interviews. We asked participants for permission to use anonymous citations prior to their inclusion in the report and/or publication.

### Data analysis

We analysed the records of the interviews using an enterprise architecture approach, which provides a conceptual framework to describe and analyse the architecture of a system by developing process maps or graphical representations of end-to-end processes that describe the stakeholders and necessary activities to complete a process.<sup>30</sup> Business process maps of the system before and during the pandemic were developed. Two members of the research team reviewed the records and the attached field notes. They then met to compare their interpretations of the data, reviewing it for clarity and completeness. Discrepancies were resolved through discussion and modifications to the process map were made, as necessary. Also, we used the recordings and written notes to list the main quotes that exemplify the changes encountered during the pandemic.

### Patient and public involvement

During the planning stage of the study protocol, the study team met with the Loreto Health Directorate (DIRESA), who informed us of the need to know the real number of deaths. For this, we proposed as a first stage to understand how the certification of deaths during the pandemic had occurred through a mapping of processes and interviews. The participants (ie, respondents from the institutions)

did not participate directly in the design of the study, but the study team did coordinate with the DIRESA of Loreto who had seen the study protocol and provided access to the first participants to interview. The participants could suggest other possible key actors within the process to include in the study (ie, snowball methodology). The results of the study have been sent to the region by letter and the report addressed to the director general of the DIRESA of Loreto.

## RESULTS

### Overview

We interviewed 28 key informants. Of these, 17 (60.7%) participants were women and 11 (39.3%) men. All participants agreed that the death certification process was majorly impacted during the pandemic, especially between April and June, when the ‘wave’ peaked. We systematised the narratives of the participants about the intervening actors and the processes that changed during the pandemic.

The existing process of death certification in Peru is described in online supplemental file 1. Briefly, there are two stages. First, a medical death certificate is issued by a doctor who knew the patient or who confirmed the death using the online SINADEF or using a paper format, which is then entered into SINADEF. Next, to obtain a death certificate issued by the National Registry of Identification and Civil Status (RENIEC), which is the final document with legal value, it is mandatory for the family to visit a civil registry office with the medical death certificate in physical form (printed or original). The family is usually the one who takes care of all the procedures to obtain the certification, although funeral homes also offer to do all the paperwork. There are several points where the process can be interrupted, and it is entirely up to the family to choose whether to report the death, obtain a certificate and how to dispose of the body.

### Actors

As a first step, we identified the actors involved in the death certification process in Loreto, Peru. The number of actors involved increased from 13 before the pandemic to 21 during the pandemic (or 62% more (table 2)). Also, the interactions between the different actors before and during the pandemic are shown in figures 1 and 2). The family of the deceased acts as the main axis of the certification process. Before the pandemic, the family needed to interact with up to 10 institutions to complete the death certification process. During the pandemic, this interaction took place with up to 19 institutions. This increase in interactions is explained by the burden of the family to complete the different administrative tasks of the death certification process. Funeral homes, in addition to helping with burial, could take over all administrative tasks at the request of family members, placing it as another main node in the process.

### Impact of the pandemic on death certification

Interviews and documentary analysis showed that there were important changes during the studied months of the COVID-19 pandemic in Loreto. The period from April to August 2020, in particular, was characterised by a collapse of the health system caused by the enormous overload of patients and the limited availability of both human and material resources. Full description of these impacts is shown in online supplemental file 2).

- ▶ Large number of deaths per day  
During the week of May 3–9, Loreto’s health sector reported more than seven times the weekly historical average number of deaths, but the interviewees affirmed that this mortality was underestimated by approximately between 20% and 30%. A large number of deaths occurred both in hospitals and in the community, and that they could not cope with the removal and storage of the corpses.

“That week was terrible, there was no way to prioritize places, people died at home. At the hospital, people died in the same queue waiting for care. In a single day I collected more than 40 corpses in the hospital, thank God the army supported us.” (Loreto, 2021)

- ▶ Fear of handling corpses  
The fear of the corpses of people suspected of having COVID-19 was present during the first 6 months of the pandemic. A MINSA regulation in March 2020 called for cremation only and did not allow family members to approach the corpses, and later when burials were allowed, there was fear in the population of being infected by contact with the corpse. Many people did not respond to the call to mobilise the corpse and/or collect the documents.
- ▶ Establishment of new entities to respond to the pandemic  
An office of DIRESA Loreto, the Directorate of Environmental Health (DESA), was activated as responsible for a new function: the removal of corpses and their mobilisation to the crematorium or cemeteries called COVID-19 cemeteries. However, interviewees reported that due to the shortage of available doctors, there were cases in which the DESA was able to remove the body, many times without the express notification of the family, due to current regulations or due to the lack of response of the relatives to the call. In these cases the death certificate was not issued, leaving the family’s responsibility to insist on producing the medical certificate of death.
- ▶ Opening of COVID-19 cemeteries  
New cemeteries to bury the bodies of people suspected of COVID-19 appeared were created by the Regional Health Directorate due to the large number of corpses they had to handle, with mass graves where 3–4 corpses were buried in the same space. In these places, it was not necessary to have a death certificate.
- ▶ Loss of corpses

**Table 2** Actors involved in death certification

Name	Brief description
<b>Before COVID-19 pandemic</b>	
Directorate of Health (DIRESA) of Loreto	Governing body of health at the regional level. Its statistical office administers the National System of Deaths
First Level Health Facility	Primary care health centre that serves the community and can refer cases to hospitals
Regional Hospital of Loreto	Regional Hospital financed by the Comprehensive Health Insurance
Hospital EsSalud	Workers' hospital financed by Social Security
Family	Nuclear relatives of the deceased
Funeral Homes	Company that at the request of the relatives is responsible for the final disposal of the body of the deceased
INEI	National Institute of Statistics and Informatics (INEI) generates the projection of deceased at a regional and national level
Insurances Offices	Insurance office where there is an Economic Benefit in the event of death, such as Comprehensive Health Insurance, Social Security, Police, Military and Private
Municipality	Organisation in charge of managing and governing a district. Give permits for burial and cremation
Private Clinic	Private companies that provide health services
Public Ministry—Morgue	Institution in charge of issuing death certificates to all deaths from external causes (possible criminal causes)
Civil Registry Office	Office of the National Registry of Identification and Civil Status in charge of issuing the valid death certificate for legal purposes
Official Cemeteries	Place approved by the municipality where the corpses are deposited
<b>Included during COVID-19 pandemic</b>	
COVID/Unofficial Cemeteries	Place not approved by the municipality where the corpses of the COVID-19 cases were deposited
Epidemiology Office (CDC)	Office of the National Center for Epidemiology, Prevention, and Disease Control (CDC). During the pandemic, they investigated the cases and deaths from COVID-19
Crematoria Offices	Place where corpses are cremated. During the first stage of the pandemic, only cremations were carried out.
Directorate of Environmental Health of DIRESA	Regional directorate office that during the pandemic was in charge of the sanitation and mobilisation of the deceased bodies
Firefighters	Public service that responds to emergency calls in the community.
National Police	State institution in charge of maintaining order in the community and providing protection and assistance to people
Private Medical Doctor	Independent physicians who provide health services or issue medical certification of death
Rapid Response Team COVID-19	Multidisciplinary team that performs field work searching and investigating possible cases of COVID-19 in the community

The loss of bodies was a major problem during the pandemic, which led to no medical death certificate being issued. In health facilities, it was reported that some family members, due to fear, took the body away before the staff could notify DESA to take it to a COVID-19 cemetery. This may have led to COVID-19 deaths being affected more by registration system disruptions more than for non-COVID deaths. Another issue was overcrowding, with non-medical personnel sending bodies to DESA even before notifying the treating doctor or the family.

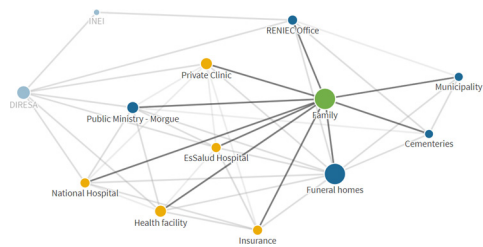
“People took the corpses because they were afraid that they would be cremated, or that they would take

them away and never hear from him again.” (Loreto, 2020)

“It was chaos, my brothers called and said their seamstress, their neighbor and her friend had died but they don't know where they are.” (Loreto, 2020)

- Greater participation of funeral homes in the certification process

During the pandemic, funeral homes played a greater role during the death certification process to assist families due to the increased burden of deaths, especially where they did not want the deceased to be buried in a COVID cemetery. However, it was reported

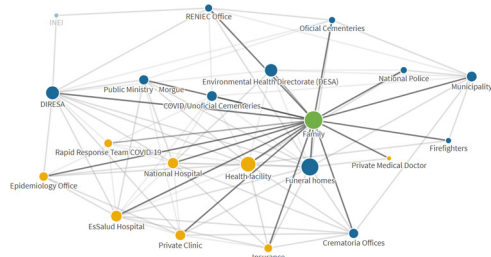


**Figure 1** Actors involved in death certification before COVID-19 pandemic, Loreto each node represents an institution or individual that participates in the death certification process. The green colour represents the family, the yellow colour represents institutions related to the provision of health services and the blue colour represents civil and social organisations (eg, cemeteries, funeral homes, civil registry offices, municipalities). DIRESA, Loreto Health Directorate; INEI, National Institute of Statistics and Informatics; RENIEC, National Registry of Identification and Civil Status.

that in several cases the intervention of the funeral home was counterproductive because they issued many medical death certificates on paper which were not sent to DIRESA. Of those that did arrive, they were in outdated formats or, because they were photocopies, there were many paper certificates with the same serial number.

- **Closure of the civil registry office**  
During the pandemic, civil registry offices were closed and all procedures were carried out virtually. Obtaining the RENIEC death certificate could only be carried out if the medical death certificate had been conducted online through SINADEF. If the medical death certificate had been issued on paper, the process could not be carried out and it was up to the family to try to have the medical death certificate issued again through SINADEF.

“If the funeral home did not make a medical death certificate with SINADEF, they could not have the certificate, Reniec would not accept it. There,



**Figure 2** Actors involved in death certification during COVID-19 pandemic, Loreto each node represents an institution or individual that participates in the death certification process. The green colour represents the family, the yellow colour represents institutions related to the provision of health services and the blue colour represents civil and social organisations (eg, cemeteries, funeral homes, civil registry offices, municipalities). DIRESA, Loreto Health Directorate; RENIEC, National Registry of Identification and Civil Status.

several were lost, several deaths were never registered.” (Loreto, 2020)

- **More use of SINADEF online**  
The increase in the number of medical death certificates made with SINADEF online caused issues, because doctors did not want to use the online system due to poor internet or lack of computers. However, the number of certificates using SINADEF online increased because the families demanded that the medical death certificate be issued online.
- **More than one medical death certificate per person**  
There was a high number of cases in which two or more medical death certificates issued in the name of the same person were found. This was due to a paper medical death certificate being completed again using SINADEF online to access a death certificate issued by RENIEC, or families obtaining a new certificate due to fear that the diagnosis of COVID-19 would appear as the cause of death, which would make the wake, burial and possible transfer of the body impossible.

### Key changes in death certification process before and during the pandemic

During the interviews, we identified the processes and subprocesses to report and certify a death before and after the COVID-19 pandemic for deaths that occurred in a health facility and in the community. The narrative detail and maps of the processes in each scenario are shown in online supplemental file 1, and a summary presented in [table 3](#).

During the pandemic, situations arose where a death could be left without registration in SINADEF. This included when the family, for fear of the loss of the body, removed the body from the health facility before notifying the physician or when hospital staff sent the body to a COVID-19 cemetery before to coordinate the notification of the treating physician. Also, due to the RENIEC death certificate only being able to be obtained if the medical death certificate had been made with SINADEF online, family members of those cases who had a paper medical death certificate had to return to the health centre to request a new one, find another doctor to make a new certificate using SINADEF online, or simply stopped trying and that death was not registered in RENIEC.

Another situation, when a death occurred in the community, was that instead of the family notifying a doctor to issue a medical death certificate, the family could request help from funeral homes, which offer a medical contact to evaluate the case and issue the medical death certificate (often discreetly because this is not part of the funeral home’s official services). In those cases, if the certificate is completed by paper and not online, the death would not be registered in SINADEF.

Finally, during the pandemic, there were deaths in the community that did not occur at home (ie, in public places). In those cases, police, firefighters or social security intervened to call DESA and remove the body. If no

**Table 3** Summary table death certification processes before and during COVID-19 pandemic

Death in a health facility		Death in community	
Before COVID-19 pandemic	During COVID-19 pandemic	Before COVID-19 pandemic	During COVID-19 pandemic
<b>Death occurs</b>			
Treating physician is notified	Could be various scenarios:	The family can choose not to inform, and they bury the body on their own.*	If death occurs outside the house, Directorate of Environmental Health remove the corpse and send it to COVID crematorium or cemetery*
	<ul style="list-style-type: none"> <li>▶ The family, fearing the loss of the body, remove the body before notifying*</li> </ul>	If the family want to inform, a physician is notified. It could be:	If death occurs in the house, the family can choose not to inform, and they bury the body on their own*
	<ul style="list-style-type: none"> <li>▶ Hospital staff send the body to a COVID cemetery before notifying the treating physician*</li> </ul>	<ul style="list-style-type: none"> <li>▶ A physician who knows the case and works in a health facility</li> </ul>	If the family want to inform, a physician is notified. It could be:
	<ul style="list-style-type: none"> <li>▶ Treating physician is notified and can continue with the following processes</li> </ul>	<ul style="list-style-type: none"> <li>▶ A physician who knows the case but doesn't work in a health facility</li> </ul>	<ul style="list-style-type: none"> <li>▶ A physician who knows the case and works in a health facility</li> </ul>
		<ul style="list-style-type: none"> <li>▶ A physician who doesn't know the case but is brought by the funeral home to evaluate the case</li> </ul>	<ul style="list-style-type: none"> <li>▶ A physician who knows the case but doesn't work in a health facility</li> </ul>
			<ul style="list-style-type: none"> <li>▶ A physician who doesn't know the case but is brought by the funeral home to evaluate the case.</li> </ul>
			<ul style="list-style-type: none"> <li>▶ A physician from the rapid response team who doesn't know the case but goes to the house to evaluate the case</li> </ul>
<b>Obtaining medical death certificate</b>			
Physician issues the medical death certificate	Physician issues the medical death certificate	Physician issues the medical death certificate	Physician issues the medical death certificate
<ul style="list-style-type: none"> <li>▶ It can be done using National Death System (SINADEF) online</li> </ul>	<ul style="list-style-type: none"> <li>▶ It can be done using SINADEF online</li> </ul>	<ul style="list-style-type: none"> <li>▶ It can be done using SINADEF online</li> </ul>	<ul style="list-style-type: none"> <li>▶ It can be done using SINADEF online</li> </ul>
<ul style="list-style-type: none"> <li>▶ Or it can be done using paper format. (A copy is sent to register in SINADEF)</li> </ul>	<ul style="list-style-type: none"> <li>▶ Or it can be done using paper format. (A copy is sent to register in SINADEF)</li> </ul>	<ul style="list-style-type: none"> <li>▶ Or it can be done using paper format. (Only if the doctor works in a health establishment, a copy is sent to register in SINADEF, if not the death is not registered in SINADEF)*</li> </ul>	<ul style="list-style-type: none"> <li>▶ Or it can be done using paper format. (Only if the doctor works in a health establishment or in the rapid response team, a copy is sent to register in SINADEF, if not the death is not registered in SINADEF)*</li> </ul>
The family can decide whether to continue with the following processes to obtain the death certificate (legal)	The family can decide whether to continue with the following processes to obtain the death certificate (legal)	The family can decide whether to continue with the following processes to obtain the death certificate (legal)	The family can decide whether to continue with the following processes to obtain the death certificate (legal)
<ul style="list-style-type: none"> <li>▶ If not, they bury the body on their own†</li> </ul>	<ul style="list-style-type: none"> <li>▶ If not, they bury the body on their own†</li> </ul>	<ul style="list-style-type: none"> <li>▶ If not, they bury the body on their own†</li> </ul>	<ul style="list-style-type: none"> <li>▶ If not, they bury the body on their own†</li> </ul>

Continued



Table 3 Continued

Death in a health facility		Death in community	
Before COVID-19 pandemic	During COVID-19 pandemic	Before COVID-19 pandemic	During COVID-19 pandemic
▶ If so, they (or funeral home) must go to the civil registry offices	▶ If so, they (or funeral home) must access to National Registry of Identification and Civil Status (RENIEC) website	▶ If so, they (or funeral home) must go to the civil registry offices	▶ If so, they (or funeral home) must access to RENIEC website
<b>Obtaining death certificate</b>			
Civil registry office accepts only medical death certificate, in physical form (printed or handwritten)	RENIEC website initiate the process only if medical death certificate was made in SINADEF online	Civil registry office accepts only medical death certificate, in physical form (printed or handwritten)	RENIEC website initiate the process only if medical death certificate was made in SINADEF online
Civil registry office issues death certificate	▶ If not, the family must obtain a new medical death certificate issued by using SINADEF online or to stop in this step and bury the body on their own†	Civil registry office issues death certificate	▶ If not, the family must obtain a new medical death certificate issued by using SINADEF online or to stop in this step and bury the body on their own†
▶ Can be done using RENIEC system online	▶ If so, RENIEC website issues death certificate using RENIEC system online	▶ Can be done using RENIEC system online	▶ If so, RENIEC website issues death certificate using RENIEC system online
▶ Can be done in paper		▶ Can be done on paper	
With the death certificate, the family can request permission for burial in an official cemetery	With the death certificate, the family can request permission for burial in an official cemetery	With the death certificate, the family can request permission for burial in an official cemetery	With the death certificate, the family can request permission for burial in an official cemetery
<b>Using of the data</b>			
MINSA uses the data registered in SINADEF	MINSA uses the data registered in SINADEF	MINSA uses the data registered in SINADEF	MINSA uses the data registered in SINADEF
RENIEC uses the data registered in RENIEC system	RENIEC uses the data registered in RENIEC system	RENIEC uses the data registered in RENIEC system	RENIEC uses the data registered in RENIEC system
INEI uses the aggregated data sent by MINSA and RENIEC	INEI uses the aggregated data sent by MINSA and RENIEC	INEI uses the aggregated data sent by MINSA and RENIEC	INEI uses the aggregated data sent by MINSA and RENIEC

\*Death is not registered in SINADEF or RENIEC.

†Death is registered in SINADEF but not in RENIEC.

responsible family member was found, the body was sent to a COVID-19 cemetery without issuing a death certificate. Another important change during the pandemic is that if the deceased had not been known to a doctor and the family could not access or did not want the help of funeral homes, the family then had to contact the rapid response team who came to the home, confirmed the death and issued the medical death certificate. It is reported that the doctors of the rapid response team, who made the certificate by hand in paper format, did generate an extra copy to send it to a DIRESA digitisation point for entry to SINADEF.

## DISCUSSION

The COVID-19 pandemic in Loreto, Peru, led to substantially more deaths per day and strained the health system significantly. This study shows how the COVID-19 pandemic substantially disrupted the death certification process, which was already producing less than complete data before the pandemic, causing more potential issues to arise so that deaths are not registered (eg, caused by problems of removal and storage of the corpses, issues of fear of handling corpses and loss of corpses), more burden on the family (having to take care of additional paperwork, not knowing what process to follow, or interacting with more institutions) and leading to greater participation from unregulated organisations such as funeral homes or cemeteries. While these impacts were mainly



due to new changes such as work overload in the health system, poor communication of new ways of working and the community's fear of being infected by corpses, they were also caused by limitations of the existing processes of the death certification system before the pandemic.

Since 2015, Peru, in conjunction with the Bloomberg Philanthropies Data for Health Initiative, initiated a series of interventions to improve its CRVS system, which included the strengthening of the medical death certificate registration system (SINADEF) and the registration system of deaths in Civil Registries (RENIEC).<sup>15</sup> As a consequence of this, the Peruvian government created various regulations for how the death registration process should operate, such as the directive for the certification of deaths, the technical guide on the correct completion of death certificates and the law of cemeteries and funeral services.<sup>16 17 31 32</sup> However, there are several regulated processes that were already not being followed, due to the little diffusion of the regulations and little supervision of their compliance due to not being sanctioned, and which were exacerbated during the pandemic according to evidence from this study.

The previously identified problematic situation of doctors giving the family member the complete form without sending the lower part to MINSA, although it existed before, worsened during the pandemic, where due to the scarce attention in health facilities, private doctors and doctors recommended by funeral homes participated to a greater extent in the issuance of paper medical death certificates.<sup>33 34</sup> Another problem during the pandemic was the large circulation of obsolete forms of paper medical death certificates which could not be entered correctly in SINADEF due to funeral homes, because of a need to meet demand, generally using photocopies of obsolete formats with the same serial number.

Not having all the real processes identified, nor having a regulation adapted to them, entails a greater burden on the family, who had the main responsibility for compliance with mortality registration processes. During the pandemic, the family could potentially interact with up to 19 different institutions to complete the mortality registration process. In addition, it was solely up to the family to decide whether to notify the death, obtain a certificate or not, and consider the best way to dispose of the body. During the pandemic months studied, there was no possibility of a death being recorded in the RENIEC but not in the SINADEF because the RENIEC virtual offices only started the process if the medical death certificate had been made with SINADEF. This probably caused an increase in cases with a paper medical certificate of death where the family no longer wanted to continue with the process and that death ended without registration in SINADEF or RENIEC.

Finally, the changes produced by the COVID-19 pandemic also had the potential to impact the completeness of the Peruvian CRVS registry, both positively and negatively. Although it cannot be quantified with precision based on the findings of our study, the majority of

those interviewed consider that at least 20%–30% more deaths occurred than what was registered in the SINADEF or RENIEC systems. While these disruptions would have had some negative impact on completeness compared with earlier years, it is possible that not all the changes were detrimental to the system. There was an increase in the use of the online platform, mainly due to the closure of civil registry offices who were not accepting any paper documents. Doctors and health establishments who previously had only used paper and were reluctant to use the online platform had to commence using SINADEF, with 3000 doctors supported in this by the College of Physicians of Peru.<sup>35</sup> This could also be explained by the population beginning to demand that the medical death certificate be made only through the SINADEF, because otherwise RENIEC would not be able to generate a death certificate with legal value. This reported phenomenon is consistent with what was found in subsequent mortality reports from Loreto where, despite the end of the 'first wave' and a decrease in new cases, the number of deaths registered in SINADEF now remains above what reported in previous years.<sup>36 37</sup> Some of this increase in registered deaths could be due to continued impacts of the pandemic on actual mortality, as well as improved timeliness of registration because of the efficiency of the online system; further research is required to assess whether, and to what extent, completeness in all regions of Peru changed during the pandemic. Any increase in completeness of SINADEF during the pandemic would have implications for the measurement of excess mortality.

This is one of the first studies to show how a pandemic such as COVID-19 has affected death registration processes, and the first that we are aware of that has conducted in-depth interviews with key informants within the system.<sup>11 12</sup> It is important to consider that all the results found in this study are in the context of the most critical period of the first wave of the COVID-19 pandemic in the Loreto region. It was precisely during April and August 2020 that Loreto became the first region of Peru to exceed its historical weekly average of deaths by more than seven times, a situation that has not since repeated.<sup>37 38</sup> The results obtained in this study, therefore, reflect the changes produced in a period of crisis and that could occur again if the appropriate measures are not taken to improve the processes. The findings also are based on interviews with representatives from various institutions involved in death certification, but did not include the perspectives of families. The findings can serve to prepare for future outbreaks or pandemics, not only in Peru but in other countries with similar CRVS system characteristics. For example, deficiencies in the CRVS system are likely to be exacerbated during the pandemic, as shown with the problems in Peru caused by lack of supervision of death certificate data collection. Hence, countries should endeavour to conduct in-depth assessments of their system and seek to rectify such issues, which will help the system to produce better quality data at all times and not just in a pandemic. Additionally,



countries should seek to digitise their system which this study showed to be more resilient during a pandemic than paper-based systems.

## CONCLUSION

The mortality registration process in Loreto, Peru, before and during the COVID-19 pandemic shows a high degree of fragmentation with little coordination and little knowledge of the regulations between the different actors. There are actors that became more relevant during the COVID-19 pandemic and that are not part of the official CRVS process. It is necessary to specifically regulate the role of funeral homes and cemeteries in supporting the medical certification and registration of the deceased in SINADEF and RENIEC. Including sanctions and those responsible for supervising such support. It is also important to adapt the regulations and strengthen the role of MINSA and DIRESA as health authorities for the effective control of medical death certification online and on paper. This includes effective coordination to redesign the processes with all the actors that actually interact in the mortality registration process. Process mapping studies are necessary to show how processes actually occur and if what is regulated is in accordance with reality. It is suggested to use these results as a first step to generate a more integrated and complete mortality registry system.

**Acknowledgements** The authors acknowledge the Regional Directorate of Loreto, especially the health personnel of the headquarters and the statistics department, who provided us with the facilities and logistical support necessary to carry out the interviews and process mapping.

**Contributors** JS-V participated in the conception of the research, data collection, data analysis, the writing of the article and approval of the final version of the article to be published, and is responsible for the overall content as the guarantor. TA participated in the conception of the research, review of the preliminary data, in the writing of the article and approval of the final version. JH participated in the conception of the research, review of the preliminary data and approval of the final version. GM participated in the conception of the research, in the data collection, writing of the article and approval of the final version. JVH participated in the conception of the research, in the data collection, data review, writing of the article and approval of the final version.

**Funding** This study was conducted during the civil registration and vital statistics (CRVS) Fellowship of JS-V. The CRVS Fellowship Program was funded under an award from Bloomberg Philanthropies and the Australian Department of Foreign Affairs and Trade to the University of Melbourne to support the Data for Health Initiative (grant number N/A). The funders had no role in study design, analysis and preparation of the manuscripts or decision to publish.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** Ethics approval was obtained from the Ethics Boards of the Universidad Nacional Mayor de San Marcos (CIEI-2021-08) in Lima, Perú.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data relevant to the study have been included in the article and as supplementary information. Further data are available from the authors upon reasonable request.

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## How has COVID-19 impacted the civil registration and vital statistics system in Loreto, Perú? Evidence using process mapping and qualitative analysis.

### Supplementary File 1

#### Death certification process in Perú

##### Overview

In general terms, death certification in Peru has two main stages. The first stage is obtaining the medical death certificate, which is issued by a doctor who knew the patient or who confirmed the death. To issue this, the doctor can use an online system on the website of the National Death System called "SINADEF" or use a paper format. However, this paper format should then be entered into the SINADEF system. According to current Peruvian regulations, the medical death certificate (printed or on paper) must be cut in two. The upper part should be given to relatives and the lower part is sent to the DIRESA for statistics. Once with the medical death certificate, the second stage consists of issuing the death certificate issued by the National Registry of Identification and Civil Status (RENIEC), which is the final document with legal value. To do this, it is necessary to go to a civil registry office with the medical death certificate in physical form (printed or handmade). It is not necessary for the applicant to be a family member. The office issues the death certificate through a RENIEC web system or by making it on paper. When they use the RENIEC web system and the medical death certificate was made in SINADEF, the process is streamlined since both systems can share information.

The family is usually the one who takes care of all the procedures to obtain the certification, although funeral homes also offer to do all the paperwork. Throughout the process, there are several points where the flow can be interrupted, and it is entirely up to the family to choose whether to report the death, obtain a certificate and how to dispose of the body. Other organizations also intervene such as the municipality (which gives permission for burial), cemeteries (official cemeteries that request the certificate and unofficial cemeteries that do not request it), the MINSAs and DIRESAs (that monitors SINADEF and generates vital statistics reports) and the INEI (which does not interact directly with the family but is responsible at the national level for generating population projections using mortality data).

These two stages occur as long as a violent death is not suspected. When it is suspected that the death was violent, that is, it was due to external causes (accident, homicide, suicide), the certification must go through a legal medical process that has its own flow.

Although there are publications and regulations on what the death certification process and flow should look like, it may not be the same in real life. That is why in this study to map how COVID-19 changed death certification, we first began to map the actors involved and processes that were carried out for death certification before and after the COVID-19 pandemic: both in a death that occurred in a health facility, and in a death that occurred in the community.

## Death certification in a health facility before COVID-19.

### Loreto-Perú

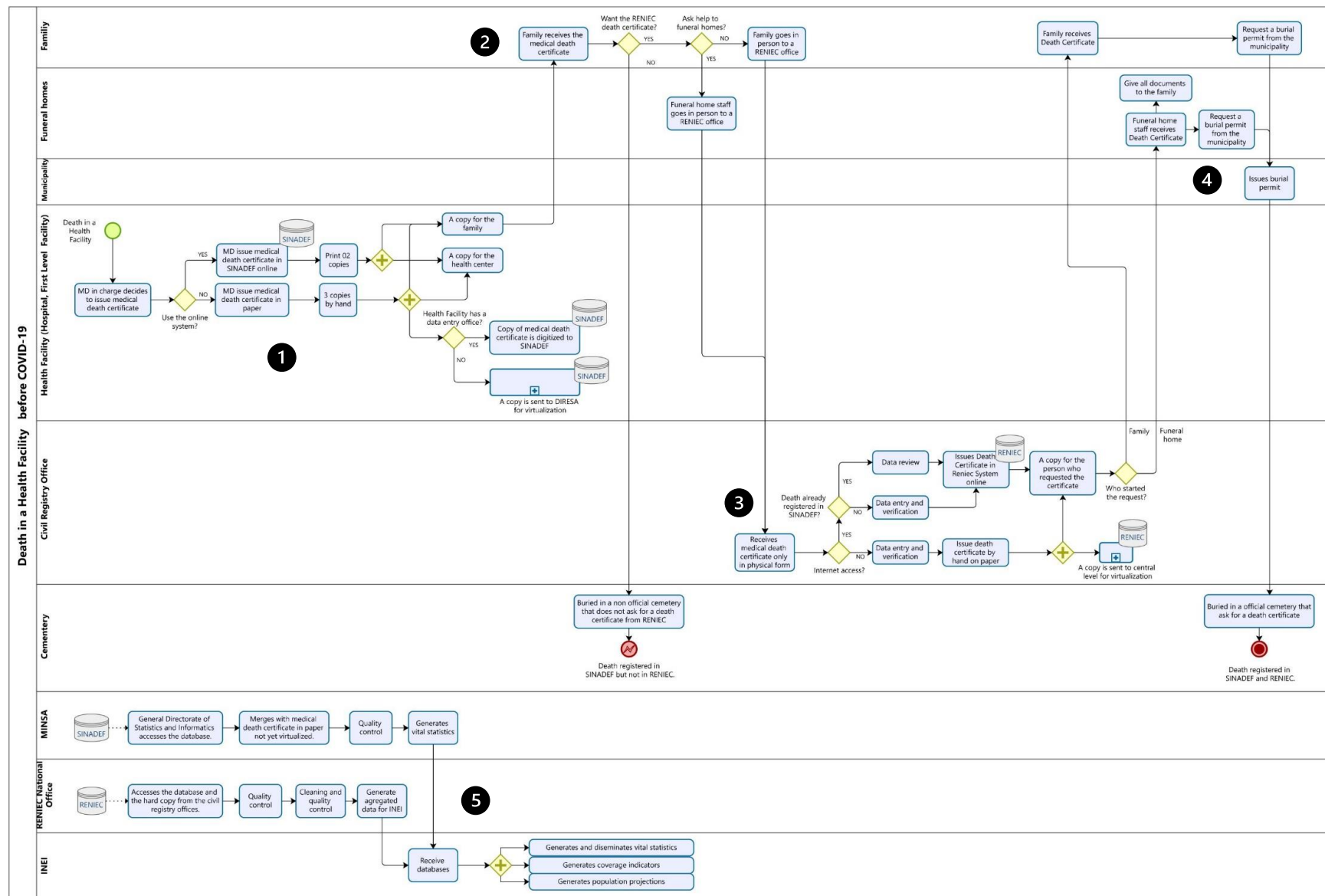
In Figure S1 we can see the mapping of the certification process of a death that occurred in a health facility. When we refer to a health establishment, it can be from a first level health center to a highly complex hospital of the different health subsystems (Comprehensive Health Insurance, Social Security-EsSalud, Police, Armed Forces, and private companies). Although they may have parallel processes depending on the type of establishment, for death certification they all comply with the following sequence of processes:

1. When death occurs in the health facility, the treating physician is notified to issue the medical death certificate. If the appropriate conditions are met (availability of computers, internet, prior training) the doctor can choose to issue the medical death certificate through the SINADEF online system.
  - 1.1 If the physician uses the SINADEF online system, the data entered is shared in real time with DIRESA and MINSa. The doctor then prints two copies, one of which remains in the deceased's medical record and the other is given to the family.
  - 1.2 If the physician does not use the SINADEF online system, he/she must use a paper format that DIRESA distributes to the different health establishments. This paper format has a unique identification to avoid duplication. Although the format according to current regulations should be divided into two to give it to the family and DIRESA; the interviews reported that physicians actually preferred to make three copies of the form by hand. This is because other institutions such as Banks and Insurance request the complete certificate and not itemized. One of the three copies remains in the deceased's medical record, the other copy is given to the family and the last copy is sent to a statistical office of the establishment so that SINADEF can later be entered. If the health facility does not have an office that can perform this task, the paper is compiled and taken to DIRESA where the data is entered into SINADEF.
2. Once the establishment provides the family with the medical death certificate and the corpse, the family can decide if they want to continue with the procedures to obtain the death certificate from RENIEC.
  - 2.1 If the family does not wish to continue, they bury the corpse in a cemetery that does not request the death certificate from RENIEC. This death ends up registered in the SINADEF system, but not in the RENIEC system.
  - 2.2. If the family wishes to continue, they themselves can go to a civil registry office or they can contract with a funeral home to complete all the missing paperwork.
3. The civil registry office only accepts to carry out the procedure if the applicant comes with the medical death certificate, in physical form (printed or handwritten). If the civil registry office has internet, staff can use RENIEC's online system where the data entered is shared in real time with

RENIEC at the central level. Additionally, they search if said death is already registered in SINADEF, since if so, the death certificate is extracted, reviewed and generated more quickly. If the office does not have internet, the death certificate is generated by hand and an extra copy is made to send to another office to digitize the data in the RENIEC system.

4. The RENIEC death certificate is delivered to the person who requested the procedure and the family or funeral home requests permission from the municipality to carry out the burial in an official cemetery that does request all the documentation. This death ends up registered in both the SINADEF system and the RENIEC system.
5. The use of all the data is carried out by the MINSA, the National Office of RENIEC and the INEI. The MINSA, through its statistics and informatics office, accesses the SINADEF, performs quality control and enters any medical death certificate that is still missing to generate periodic vital statistics. The RENIEC National Office does the same with its database. Finally, both entities send the aggregated information to the INEI so that they can generate population projections and different coverage indicators.

Figure S1. Death certification in a health facility before COVID-19



## Death certification in a health facility during COVID-19.

### Loreto-Perú

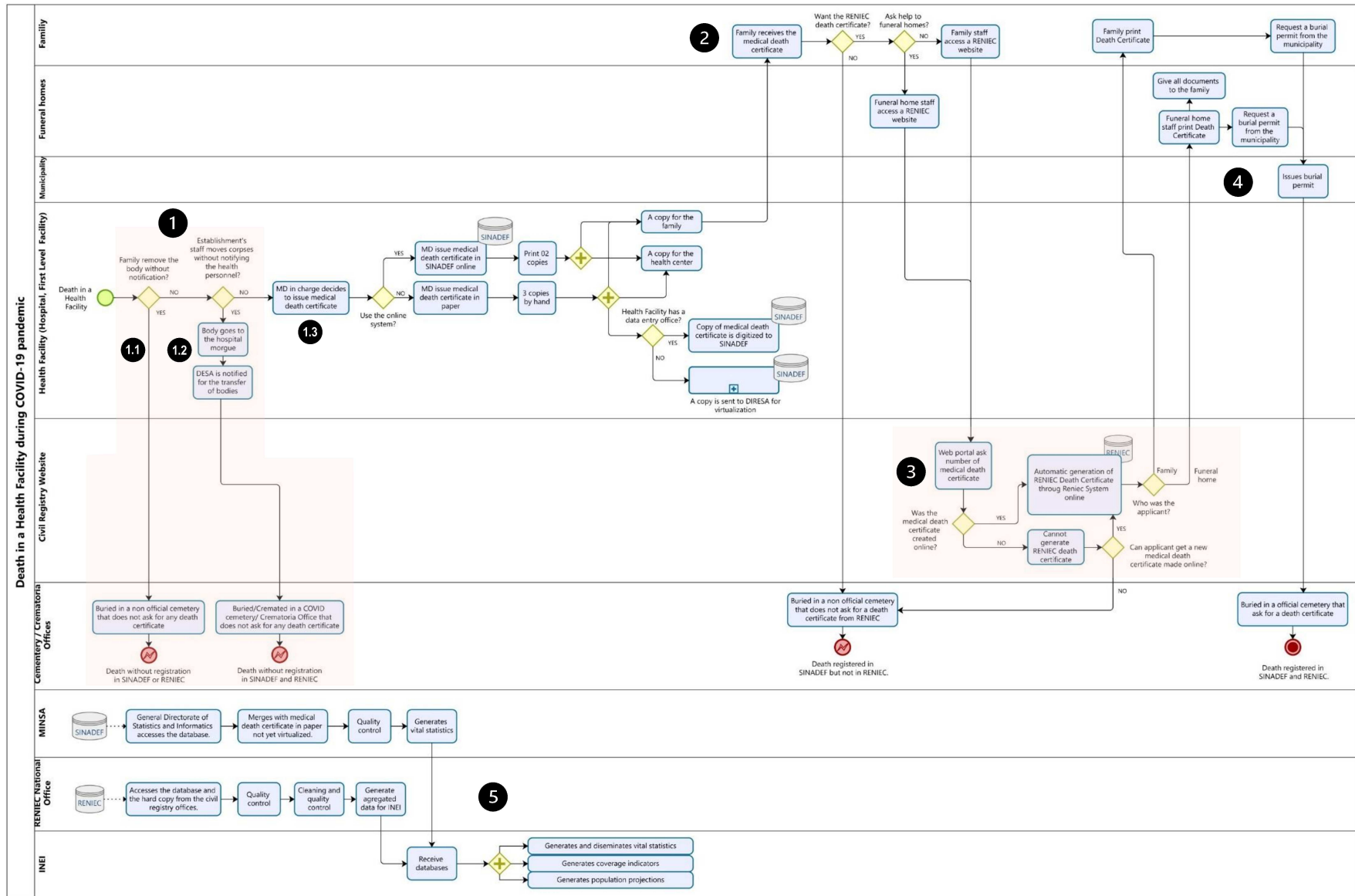
In Figure S2 we can see the mapping of the certification processes of a death that occurred in a health facility during the COVID-19 pandemic in Loreto.

1. During the pandemic, when a death occurred in the health facility, the corpses were packaged and transferred to the facility's morgue or to a defined space within the facility. DESA carried the bodies for cremation or burial in COVID cemeteries.
  - 1.1 In the first instance, it could happen that the family, fearing that the DESA would take the body, removed it without notifying anyone. In these cases, the corpse was buried in a cemetery that did not request a death certificate, generally on land owned by the family or owned by the community. This death ended without registration in SINADEF nor in RENIEC.
  - 1.2 There were also reports of cases in which the same non-medical personnel of the establishment took the body and sent it to the DESA without notifying the health personnel who had not yet initiated the medical death certificate. The corpse was cremated or buried in a COVID cemetery without obtaining a medical death certificate. This death ended without registration in SINADEF nor in RENIEC.
  - 1.3 If the treating physician is notified to issue the medical death certificate, he or she can use the SINADEF online system or do so using a paper format. If the doctor used SINADEF online, he had to print two copies, one for the medical record and one for the family; otherwise, the doctor had to make three copies of the paper form by hand. One of the copies by hand remains in the clinical history of the deceased, another copy is given to the family and the last copy is sent to a statistical office of the establishment or the DIRESA so that it can later be entered in SINADEF. In this case, the body was not mobilized by DESA, but the family member could request the funeral home to mobilize the corpse following established health protocols.
2. Once the family obtains the death certificate, the family can decide if they want to continue with the procedures to obtain the death certificate from RENIEC.
  - 2.1 If the family does not wish to continue, they bury the corpse in a cemetery that does not request the death certificate from RENIEC. This death ends up registered in the SINADEF system, but not in the RENIEC system.
  - 2.2 If the family wishes to continue, they themselves can go to a civil registry office or they can contract with a funeral home to complete all the missing paperwork.
3. During those months of the pandemic, the Civil Registry offices stopped opening and all procedures were carried out through its website. Because there were no face-to-face personnel who could validate the information, they only agreed to issue the death certificate if the medical death certificate had been generated by the SINADEF system.



- 1.1 If the applicant had a medical death certificate that had been generated using SINADEF online, there was no problem. The website of the Civil Registry automatically generated the death certificate using the information entered and validated by the doctor.
  - 1.2 If the applicant only had a medical certificate made by hand on paper, the RENIEC website would not be able to generate the death certificate. This forced the family member to consider the possibility of obtaining a new medical death certificate, but this time using the SINADEF online system.
4. The RENIEC death certificate is delivered to the person who requested the procedure and the family or funeral home requests permission from the municipality to carry out the burial in an official cemetery that does request all the documentation. This death ends up registered in both the SINADEF system and the RENIEC system.
5. The use of all the data was carried out without changes, where the MINSAs, the National Office of RENIEC and the INEI used the information to generate periodic vital statistics, population projections and different coverage indicators.

Figure S2. Death certification in a Health Facility during COVID-19



## Death certification in the community before COVID-19.

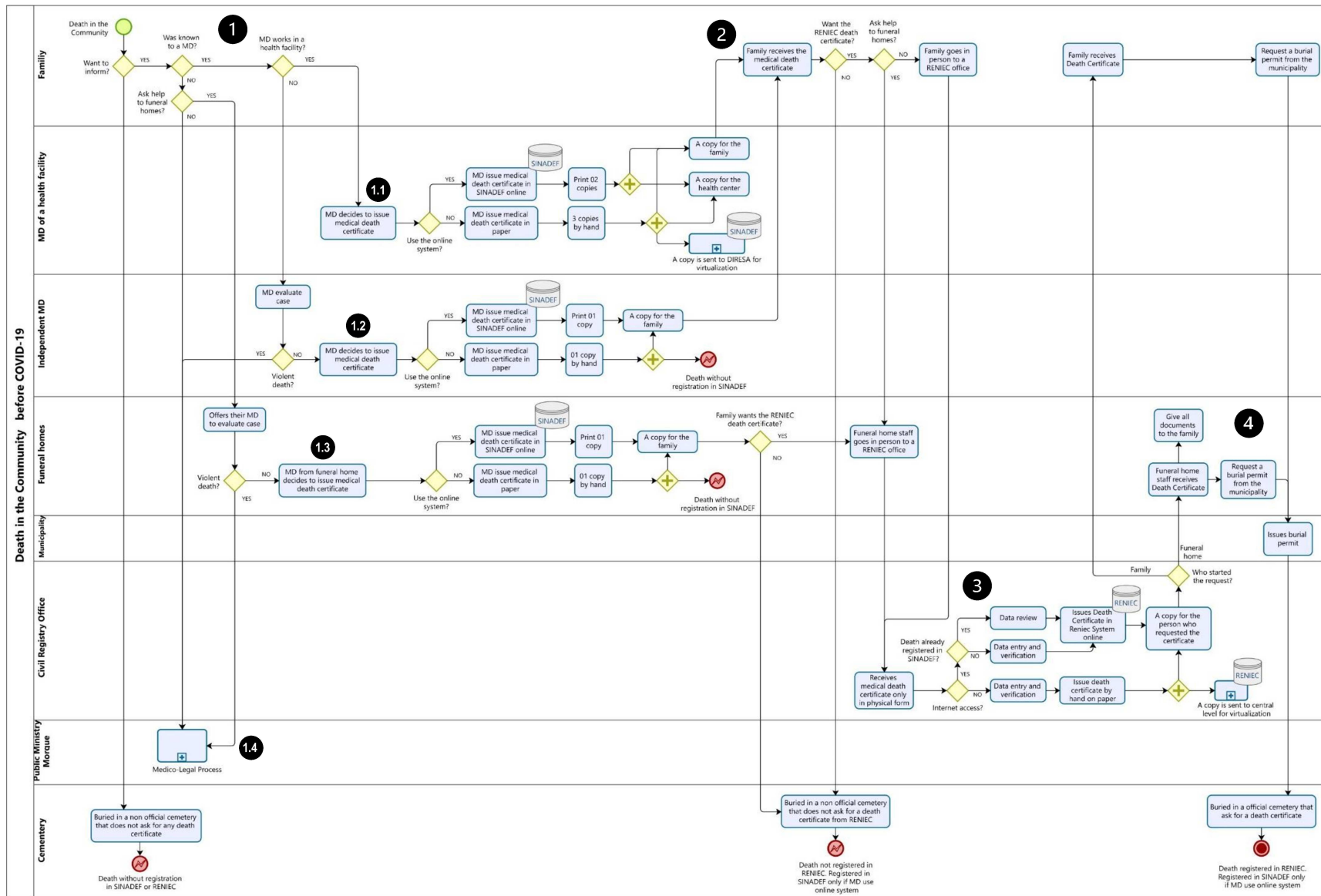
### Loreto-Perú

In Figure S3 we can see the mapping of the certification processes of a death that occurred in the community.

1. When death occurs in the community, the family decides whether or not they want to report the death and follow the process to obtain the death certificate. If the family decides not to proceed and not notify the death, the corpse is buried in a cemetery that does not request a death certificate, generally on the family's or community's own land. If the family decides to report the death to obtain the death certificate, the process continues depending on whether there is a physician who knew the patient or who can verify the death.
  - 1.1 If the deceased has been known to a doctor who works in a health establishment, he or she could appear personally to issue the medical death certificate. To do this, the doctor can use the SINADEF online system and print two copies, one for the medical record and one for the family. If the doctor does not use the SINADEF online system, the doctor uses a paper format and makes three copies by hand. One of the copies remains in the clinical history of the deceased, another copy is given to the family and a copy is sent to a statistical office of the establishment so that it can later be entered in the SINADEF.
  - 1.2 If the deceased has been known to a doctor who does not work in a health establishment, he or she could appear personally to evaluate the case to rule out a possible violent death and to make the medical death certificate. To do this, the doctor can use the SINADEF online system or obtain a paper form and do it manually. In this case, if the medical death certificate is made on paper, it is mentioned that the doctor does not send a copy for data entry, so the death is not registered in the SINADEF system.
  - 1.3 If the deceased has not been known to a doctor, the interviewees report that the family can request help from funeral homes, which offer a medical contact to evaluate the case and issue the medical death certificate. This offer is not part of the official services of the funeral home, so it is done discreetly. The physician suggested by the funeral home can use the SINADEF online system or obtain a paper form and do it manually. In the event that the medical death certificate is made on paper, it is mentioned that no copy is sent for data entry, so the death remains without registration in the SINADEF system.
  - 1.4 If the deceased has not been known to a doctor, and the family is unwilling or unable to request help from funeral homes, they must follow a legal medical process, where the morgue defines the cause of death.

2. Once the family obtains the death certificate, the family can decide if they want to continue with the procedures to obtain the death certificate from RENIEC.
  - 2.1 If the family does not wish to continue, they bury the corpse in a cemetery that does not request the death certificate from RENIEC.
  - 2.2 If the family wishes to continue, they themselves can go to a civil registry office or they can contract with a funeral home to complete all the missing paperwork.
3. The civil registry office only accepts to carry out the procedure if the applicant comes with the medical death certificate, in physical form (printed or handwritten). If the civil registry office has internet, staff can use RENIEC's online system where the data entered is shared in real-time with RENIEC at the central level. Additionally, they search if said death is already registered in SINADEF, since if so, the death certificate is extracted, reviewed, and generated more quickly. If the office does not have internet, the death certificate is generated by hand and an extra copy is made to send to another office to digitize the data in the RENIEC system.
4. The RENIEC death certificate is delivered to the person who requested the procedure and the family or funeral home requests permission from the municipality to carry out the burial in an official cemetery that does request all the documentation. This death ends up registered in the RENIEC system and in the SINADEF only if the medical death certificate was made online.
5. The use of all data is carried out by the MINSAs, the National Directorate of RENIEC and the INEI in the same way that occurs when death occurs in a health facility.

Figure S3. Death certification in the community before COVID-19



## Death certification in the community during COVID-19.

### Loreto-Perú

In Figure S4 we can see the mapping of the certification of a death that occurred in the community during the COVID-19 pandemic. It should be noted that during the months studied, all deaths in the community were considered probable cause of COVID-19.

1. During the pandemic, a death in the community could occur at home or on the street. If a death occurred on the street, community members could call the police, the local security, or the fire department. They arrived to verify the fact, try to locate the family, and contact DESA to carry out the removal of the corpse. Then the corpse was taken to the COVID crematorium or cemetery and said death was not registered in SINADEF nor in RENIEC. If the death occurred at home, the process continues depending on whether the family wanted to inform and if there was a doctor who knew the patient or who could verify the death.
  - 1.1 If the death had occurred at home and the family decided not to follow the process to obtain the death certificate and rather wishes to bury the body as soon as possible, the family could request help to remove the body; or carry out the burial.
    - 1.1.1 If the family asked the police, the local security or fire department for help to remove the body, they would verify the fact and contact DISA. DISA then took the body to cremation or to the COVID cemetery. This death was not registered in SINADEF nor in RENIEC.
    - 1.1.2 If the family decided to take charge of the burial, the body was buried in an unofficial cemetery because it was decided not to obtain the death certificate.
  - 1.2 If the death had occurred at home and the family wanted to follow the process to obtain the death certificate, four situations could arise:
    - 1.2.1 If the deceased has been known to a doctor who works in a health facility, he or she could appear in person to issue the medical death certificate. To do this, the doctor could use the SINADEF online system and print two copies, one for the medical record and one for the family. If he was not using the SINADEF online system, the doctor used the paper format and made three copies by hand. One of the copies for the deceased's medical record, another copy for the family, and a copy was sent to a statistical office of the establishment or DIRESA so that it could later be entered into the SINADEF.
    - 1.2.2 If the deceased had been known to a doctor who did not work in a health establishment, he could appear in person to rule out a possible violent death and make a medical death certificate. For this, the doctor could use the SINADEF online system or obtain a paper format and do it manually. If the medical death certificate is made on paper, it is mentioned that the doctor did not send a copy for data entry, so that death was not entered into the SINADEF system.

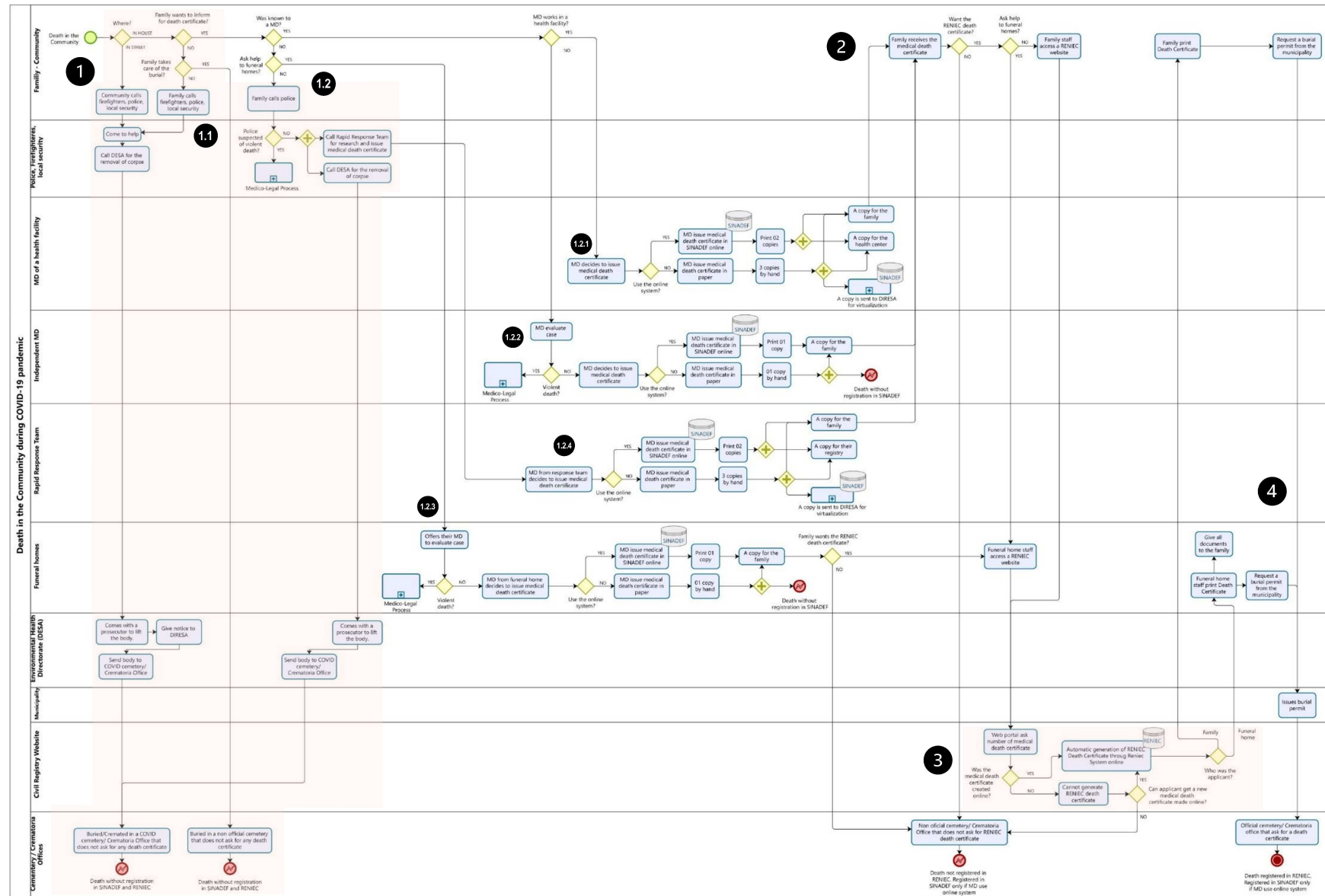
- 1.2.3 If the deceased had not been known to a doctor, the family could ask funeral homes for help, which unofficially offered a medical contact to evaluate the case and issue the medical death certificate. The doctor suggested by the funeral home could decide to use SINADEF's online system or get a paper form and do it manually. If the medical death certificate was made on paper, it is mentioned that a copy was not sent for data entry, so that death was not entered into the SINADEF system.
    - 1.2.4 If the deceased had not been known to a doctor, and the family did not want or could not ask for help from the funeral homes, the family called the police, who verified the fact and ruled out a possible violent death in the first instance. If there was suspicion that it was a violent death, the family had to follow a legal medical process, where in the morgue they had to define the cause of death. If the police did not suspect that it was a violent death, they called DESA and the rapid response team to issue the medical death certificate. The rapid response team physician could decide to use SINADEF's online system or get a paper form and do it manually. If it is done manually, a copy is sent to DIRESA so that it can later be entered in SINADEF.
  - 2 Once the family obtains the death certificate, the family can decide if they want to continue with the procedures to obtain the death certificate from RENIEC.
    - 2.1 If the family does not wish to continue, they bury the corpse in a cemetery that does not request the death certificate from RENIEC. This death ends up registered in the SINADEF system, but not in the RENIEC system.
    - 2.2 If the family wishes to continue, they themselves can go to a civil registry office or they can contract with a funeral home to complete all the missing paperwork.
  - 3 During those months of the pandemic, the Civil Registry offices stopped opening and all procedures were carried out through its website. Because there were no face-to-face personnel who could validate the information, they only agreed to issue the death certificate if the medical death certificate had been generated by the SINADEF system.
    - 3.1 If the applicant had a medical death certificate that had been generated using SINADEF online, there was no problem. The website of the Civil Registry automatically generated the death certificate using the information entered and validated by the doctor.
    - 3.2 If the applicant only had a medical certificate made by hand on paper, the RENIEC website would not be able to generate the death certificate. This forced the family member to consider the possibility of obtaining a new medical death certificate, but this time using the SINADEF online system.

2. The RENIEC death certificate is delivered to the person who requested the procedure and the family or funeral home requests permission from the municipality to carry out the burial in an official cemetery that does request all the documentation. This death ends up registered in the RENIEC system and in the SINADEF only if the medical death certificate was made online.

The use of all the data was carried out without changes, where the MINSA, the National Office of RENIEC and the INEI used the information to generate periodic vital statistics, population projections and different coverage indicators.



Figure S4. Death certification in the community during COVID-19



## How has COVID-19 impacted the civil registration and vital statistics system in Loreto, Perú? Evidence using process mapping and qualitative analysis.

### Supplementary File 2

#### Impact of the pandemic on death certification

##### 1. Large number of deaths per day

Official data from MINSA show that during the week of May 3-9, there were 374 deaths in Loreto, more than seven times the weekly historical mortality reported in previous years. However, those interviewed agree that this underestimated mortality by 20 to 30% and the number of deaths during those weeks would be much higher. A large number of deaths occurred both in hospitals and in the community, so much so that they could not cope with the removal and storage of the corpses.

*“That week was terrible, there was no way to prioritize places, people died at home. At the hospital, people died in the same queue waiting for care. In a single day I collected more than 40 corpses in the hospital, thank God the army supported us” (Loreto, 2021)*

##### 2. Fear of handling corpses

The fear of the corpses of people suspected of COVID-19 was present during the first six months of the pandemic. During the month of March 2020, MINSA issued national regulations that called for cremation only and did not allow family members to approach the corpses. This regulation changed in the following months, allowing burials to be carried out, but provoked a response of fear in the population of being infected by contact with the corpse of their deceased relative, especially because all those who died in that period were suspected to have COVID-19. This caused that many people did not respond to the call to mobilize the corpse and / or collect the documents.

*“What could I do with that attitude? The family did not approach, nobody wanted, they called them and they did not approach. What could we do? We deliver the body to the DIRESA to be taken away” (Loreto, 2020)*

##### 3. Establishment of new entities to respond to the pandemic

The Loreto Regional Health Directorate activated two important agencies for the response to the pandemic. One was the Environmental Health Directorate (DESA), which formed teams of technical personnel who were in charge, both in the community and in health establishments, of the removal of corpses and their mobilization to the crematorium or cemeteries called COVID cemeteries. Another organization was the rapid response teams, which were teams made up of a doctor, a nurse and a technician who went to the community to carry out an investigation of possible cases of COVID-19, verify the death and issue the medical certificate of death.

In the community, both organizations worked in a coordinated manner to raise the body and issue the death certificate. However, the interviewees reported that due to the shortage of available doctors, there were cases in which the DESA was able to carry out the removal of

the body, many times without the express notification of the family, due to current regulations or due to the lack of response of the relatives to the call. In these cases the death certificate was not issued, leaving the family's responsibility to insist on producing the medical certificate of death.

*"In death at home, they called the police or the prosecutor, they told the family to call DESA. DESA would arrive, take the body, and leave a form for the family to call the rapid response team." (Loreto, 2020)*

#### 4. Opening of the COVID cemetery

During the pandemic, new places used to bury the bodies of people suspected of COVID-19 appeared. These cemeteries were created by the Regional Health Directorate due to the large number of corpses they had to handle and the impossibility of cremating them all. There were mass graves where 3-4 corpses were buried in the same space. For this, it was not necessary for them to have a death certificate. All the bodies brought by DESA were buried.

#### 5. Loss of corpses

The loss of bodies was also raised as a major problem during the pandemic. In health facilities, it was reported that there were times that family members, due to fear, took the body away before the staff could notify DESA to take it to a COVID cemetery. In other cases, due to significant overcrowding, non-medical personnel sent the bodies to DESA even before notifying the treating doctor or the family. These cases ended without a medical death certificate or the family members had to find another doctor who could produce a medical death certificate. On the other hand, the relatives of whom Diresa did take the corpse reported that they had no information where they were taken, the hospital staff gave no response and there were cases where they confused the location of the deceased.

*"People took the corpses because they were afraid that they would be cremated, or that they would take them away and never hear from him again." (Loreto, 2020)*

*"It was chaos, my brothers called and said their seamstress, their neighbor and her friend had died but they don't know where they are" (Loreto, 2020)*

#### 6. Greater participation of funeral homes in the certification process

During the pandemic, funeral homes played a greater role during the death certification process. They supported the population that did not know how to proceed or did not obtain a response from the health system due to the increased burden of deaths.

Although funeral homes are not included in the official death certification process because they are private companies, they were especially useful in those cases where the relatives did not want the deceased to be buried in a COVID cemetery. They helped families with the procedures and unofficially found a doctor who could verify the death and the cause of death and issue the medical certificate, because many doctors would not provide a certificate without being able to ascertain the cause.

*"Sometimes the relatives wanted to request the medical death certificate, but the doctors did not want to give it to him. The relatives told them what he/she died of, but since they couldn't go to prove it, they didn't want to" (Loreto, 2020)*

*“The doctor from the health facility gave a thousand reasons: because he does not have the paper format, because he does not have a SINADEF username and password, etc. The easiest thing for the doctor sometimes, even when the deceased arrives in the emergency room, was to tell the family to call the funeral home because there was the idea that you are going to get in trouble if you fill out a death certificate without knowing well the cause of death” (Loreto, 2021)*

However, the interviewees also mention that in several cases the intervention of the funeral home was counterproductive because they issued many medical death certificates on paper which were not sent to DIRESA and, of those that did arrive, they were in outdated formats or because they were photocopies there were many paper certificates with the same serial number. When the funeral homes were asked, they mentioned that they did not know about the problem and that they had not had contact with any health entity with whom to coordinate.

*“The funeral homes made the certificates, in an invalid or outdated format that could not be entered later in the SINADEF. We (DIRESA) had to recover and put it on a new sheet and we would convert it to a current format. (Loreto, 2020)*

#### 7. Closure of the civil registry office

The pandemic also produced changes in the process of obtaining the death certificate from RENIEC. During the weeks studied, the civil registry offices were closed due to the declaration of national emergency and all procedures were carried out virtually through its website. Obtaining the RENIEC death certificate could only be carried out if the medical death certificate had been made through the SINADEF online system, since it automatically obtained the information from the system using the information validated by the doctor. In the event that the medical death certificate had been issued on paper, the process could not be carried out and it was up to the family to try to have the medical death certificate issued again, but this time through the system SINADEF online.

*“If the funeral home did not make a medical death certificate with SINADEF, they could not have the certificate, Reniec would not accept it. There, several were lost, several deaths were never registered” (Loreto, 2020)*

#### 8. More use of SINADEF online

RENIEC's requirement not to accept hand-drawn medical death certificates led to an increase in the number of medical death certificates made with SINADEF online. The interviewees reported that the doctors did not want to use the online system because the internet was terrible, because their passwords expired very quickly, because they did not have a computer in their work area, and because it was much easier to do it by hand. However, during the pandemic despite these difficulties, the number of certificates using SINADEF online increased because the families demanded that the medical death certificate be issued online.

*“I had seven, eight families waiting to redo the death certificate online, with the slowness of the internet I could not cope, I had to go to the medical corps office to try to do it there.” (Loreto, 2020)*

*“Internet was too slow, there were times when it took forty minutes or even an hour to make a certificate, while loading and writing.” (Loreto, 2020)*

*“Yes, I had to issue the certificates only using the online system, but it took a long time. I collected the certificates of the day and wrote them during the night, 3-4 in the morning, there the internet signal always improved a little.” (Loreto, 2020)*

#### 9. More than one medical death certificate per person

Another process that became notorious during the pandemic was the high number of cases in which two or more medical death certificates issued in the name of the same person were found. One of the reasons for this was that the cases that had a medical death certificate on paper had to be performed again using SINADEF online to access a death certificate issued by RENIEC. Another reason for obtaining a new certificate was due to the fear of the relatives that the diagnosis of COVID-19 would appear as the cause of death, which would make the wake, burial and possible transfer of the body impossible.