

**ASSESSING THE PUBLICLY SHARED  
DIGITAL HEALTH DATA IN LEBANON  
DURING THE COVID-19 PANDEMIC:**

Identifying Gaps and Providing Recommendations

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**“Assessing the publicly shared digital health data in Lebanon during the covid-19 pandemic: Identifying gaps and providing recommendations”**

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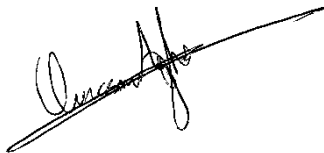
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Declaration:

Where other people’s work has been used (from either a printed or virtual source, or any other source), this has been carefully acknowledged and referenced in accordance with academic requirements.

The thesis [**Assessing the publicly shared digital health data in Lebanon during the covid-19 pandemic: Identifying gaps and providing recommendations**] is my own work.

**Signature**



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## Abstract

### Introduction

The publication of digital health data is a privacy-sensitive issue that has a significant impact on societies in general. It is a product of digital health technology, which aims to facilitate and advance health care through its systems. The world courageously faced the Covid-19 epidemic, initially gaining over it and greatly reducing its intensity. After Covid-19 epidemic, numerous technologies and evaluation systems changed, and new disciplines emerged, including digital health and its products. Information management is essential for achieving precise outcomes, and its security is crucial and often complex, particularly if data is intended to spread across platforms, applications, and websites. This study intends to assess the digital health data that was shared publicly in Lebanon during the Covid period in order to provide relevant recommendations to health policymakers in Lebanon, particularly in the area of digital health.

### Methodology

A literature review was conducted by collecting models of digital health reports published in Lebanon, totaling an estimated eight digital health platforms based on websites and applications. We then selected one of the four frameworks that focused on the classification of the digital health intervention, the "data services framework", which contributed to the analysis of these platforms via 12 standards.

### Findings

In the findings, we classified the data and its source before defining its operations and services. After that, we highlighted the impact of the digital health community in Lebanon throughout the Covid-19 period. Then, we analyzed the information of these platforms through the framework, which included 12 standards that focused on the quality of data that should be in digital health information system, such as its accuracy, cleanliness, privacy, the quality of the collection process, the accuracy of its geographical location, the accuracy of identifying the disease and its characteristics, linking information at the national level, and visualizing information in a clear understandable manner.

### Conclusions

At the conclusion of the study and analysis, numerous gaps were identified in the digital health data that was disseminated in Lebanon during the Covid period. The most notable of these gaps is the lack of information, and sometimes its inconsistency or incompleteness. We explained the factors that contributed to this through inadequate infrastructure, lack of electricity, lack of skilled specialists, inadequate communications, economic crisis, inadequate financing, inadequate digital health initiatives, and other causes that help us to understand the problem. In addition, we provided a number of recommendations aimed at assisting health policymakers in Lebanon, particularly the creators, designers, and implementers of digital health policies.

### Key words

Covid19, Digital Health Data, Health Disaster, Data Services Standards Framework, Classification of Digital health Intervention, Emergency Response, Lebanon.

**Word Count: 12328 words**

# Table of Contents

<b>Abstract.....</b>	<b>iii</b>
<b>List of Tables.....</b>	<b>vi</b>
<b>List of Figures.....</b>	<b>vi</b>
<b>Abbreviations.....</b>	<b>vii</b>
<b>Key terms.....</b>	<b>viii</b>
<b>Acknowledgements.....</b>	<b>ix</b>
<b>Introduction.....</b>	<b>x</b>
<b>Chapter 1: Background Information.....</b>	<b>1-5</b>
1.1 Covid-19 Pandemic as a Health Disaster and the Use of Digital Health Technology	
1.2 Lebanese Health System Overview	
<b>Chapter 2: Problem Statement, Justification, Objectives.....</b>	<b>6-8</b>
2.1 Problem Statement and Justification	
2.2 Objectives	
<b>Chapter 3: Methodology.....</b>	<b>9-14</b>
3.1 Study Type	
3.2 Study Area	
3.3 Recruitment, Data Category and Data Collection Method	
3.4 Data Processing, Analysis and Dissemination of the Findings	
3.5 Analytical Framework	
<b>Chapter 4: Study Results and Findings.....</b>	<b>15-23</b>
4.1 Covid-19 Pandemic in Lebanon	
4.2 Digital Health Situation in Lebanon	
4.3 The Digital Health Initiatives in Lebanon during Covid-19 Pandemic	
4.3.1 Lebanon National Operations Room/ Ministry of Public Health in Lebanon (LNOR)	
4.3.2 WHO Lebanon Daily Dashboard	
4.3.3 Lebanese Red Cross (LRC) Platform	
4.3.4 Hospitals Shared Data	
4.3.5 Ma3an" Together Against Corona	
4.3.6 Impact "COVAX"	
4.4 The Usage of the Selected Framework	
4.4.1 Data Collection, Management and Use	

4.4.2 Data Coding	
4.4.3 Location Mapping	
4.4.4 Data Exchange and Interoperability	
4.5 Data Analysis and Results	
4.5.1 General Summary	
<b>Chapter 5: Discussion.....</b>	<b>24-27</b>
5.1 General Observations	
5.2 Reflection on the Data Services Framework	
5.3 Study Advantages and Limitations	
<b>Chapter 6: Conclusions and Recommendations.....</b>	<b>28-31</b>
6.1 Conclusions	
6.2 Recommendations	
<b>References.....</b>	<b>32-36</b>
<b>Annexes.....</b>	<b>37-44</b>
<b>Research Strategy.....</b>	<b>45</b>

## **List of Tables**

Table 1 List Example on some DHI used in health disaster (7)

Table 2 Eight shared digital health data platforms of Lebanon

Table 3 Definitions of the four blocks of Data Services Framework

Table 4 Framework of data services of COVID-19 data of Lebanon

## **List of Figures**

Figure 1 Ministry of Public Health in Lebanon Organigram (19)

Figure 2 Map of Lebanon (28)

Figure 3 The Data Services Framework (4.0), Classification of Digital Health Interventions (29)

Figure 4 Data Services Framework (4.0) (30)

## Abbreviations

ACT	The Access to COVID-19 Tools Accelerator
CEPI	Coalition for Epidemic Preparedness Innovations
COVAX	COVID-19 Vaccines Global Access
COVID-19	Coronavirus Disease 2019
DHD	Digital Health Data
DHI	Digital Health Intervention
DHT	Digital Health Technology
E-Health	Electronic Health
GPS	Global Positioning System
HDF	Hôtel-Dieu de France
HIS	Health Information system
HIS	Hospital Information System
ICT	Information and Communication Technology
KIT	Royal Tropical Institute
LNOR	Lebanon National Operations Room
M-Health	Mobile Health
MoI	Ministry of Information
MoPH	Ministry of Public Health
NGO	Non-governmental Organization
NPHCN	National Primary Health Center Network
OpenHIM	Open Health Information Mediator
PCR	Polymerase Chain Reaction
PHC	Primary Health Centers
UNICEF	United Nations International Children's Emergency Fund
VU	Vrije Universiteit Amsterdam
WHO	World Health Organization

## **Key terms**

**Covid19:** SARS-CoV-2 causes COVID-19 which is an illness caused by the Coronavirus that is marked by inflammation.

**Digital Health:** Combining software, equipment, and applications, digital health extends transformational change to the healthcare profession.

**Digital Health Technology:** The purpose of digital health technology is to improve human health through the health process. It comprises wearable gadgets, hospital information systems, fitness technologies, remotely connected health tools, communication technologies, and more.

**Digital Data:** Data that reflect various types of information utilizing artificial linguistic structures that can be processed by a range of technologies.

**Health Data:** For a person or population, health data would include any information pertaining to health difficulties, the spread of a disease, the number of deaths, the number of individuals infected in a certain area, injuries caused by a health disaster, specifics and quality of life, reproductive outcomes, etc.



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Benefitting from the amazing experience and valuable knowledge I have obtained here from KIT in Amsterdam, I wish to be able to provide a valuable impact in the fields of public health locally and globally.

## Introduction

Coming from Lebanon, I am an experienced project manager and a senior consultant with over 15 years of experience in managing NGOs, social initiatives, and health facilities in Lebanon and the Middle East. Academically, I have earned a bachelor's degree in management and organization in addition to four additional diplomas in healthcare quality, non-profit management, and value chain management.

I also assisted in the establishment of one of Lebanon's digital health platforms as a part of the health services provided to persons with disabilities during the Covid-19 pandemic in Lebanon, especially for Syrians refugees in camps near the northern borders. However, it was difficult for me and my co-workers to work and operate promptly and effectively through the national response team due to the chaos in the public institutions and the variations in the data and its sources. During the peak of the pandemic waves, we were faced by a huge informational conflict among the digital health platforms that were used to relay the updates about the pandemic, and so the technical coordination at the site level with the working teams was always at huge risk.

Later, this huge chaotic and stressful experience was elaborated through a more operational experience. Following the Beirut explosion in the year 2020, I was a member of the relief team that operated at the explosion site. I noticed the power of digital health data in emergencies and health disasters. Trying to figure out the number of injuries, the number of operating health facilities in the area, the emergency phone numbers of the relief teams, and countless data needed to operate and support the teams on ground were needed but not really existing.

This accumulation of experiences piqued my interest to analyze the status quo of the digital health interventions in Lebanon; mainly the utilization of digital data platforms during emergencies. I wanted to explore how digital interventions help health managers and policy makers to take the suitable decisions in the case of emergencies. Accordingly, I'm eager to identify the gaps, analyze them, and check what developments we can contribute to in order to make the data systems better integrated and more sustainable in the future.

What we have learned in this master's program, especially in health system and management, have had a huge impact and how we can make a real change through research and policy development motivate me in figuring out the digital health status is in my home country Lebanon, especially with a focus on the experience during the covid-19 pandemic.

## Chapter 1: Background Information

Digital health is a revolution and a major technological shift in the world of health services for the development of health care through technologies, software, and inventions that include personal and community health and simplify the methods for medical intervention, whether this intervention is through mobile health technologies by mobile phones, or health information systems, digital medical follow-up, or simulating wearable devices to monitor health. In addition to supporting the detection, communication, and encoding of survey systems that aid in managing health disasters, or technology platforms, it also aids the management of medical, chemical, and pharmaceutical products. All of these efforts contribute daily to the ignorance of healthy life, the accuracy of the diagnostic process, the productivity of the management of health institutions, and the global support to the health and economic systems (1). The efforts of the World Health Organization (WHO) revolve around three basic goals to support the spread of digital health technology: promoting scientific research and innovation, as well as gathering international efforts in the framework of developing digital health support with clinical topics and research for health and medical services in general. Second, health data management, distribution, and analysis must genuinely empower global health decision-makers. Third, enabling technology that promotes proactive methods of evaluation with the goal of linking health needs across nations and activating the role of international and regional action for the public benefit (2).

It is difficult to comprehend a future without digital health technology and its implications on public health. In history, they were used to diagnose malaria, diabetes, and several infections, to manufacture medical products, prosthetics, and orthotics, and to 3D print blood carriers by drones. The current epidemic was mapped to determine its extent and spread, patients and remote contacts were tracked, and several health services were made available in a digital format that made it safe for medical personnel and patients to communicate. This section demonstrates that these technologies will continue to improve in the future. Therefore, it is essential to be able to handle, analyze, program, and comprehend health big data (3).

Imagine that the World Health Organization's member states have adopted a five-year strategy to improve international coordination and cooperation in the transfer of digital health knowledge, as well as a classification of digital health technologies based on the needs of international health systems to determine health indicators. Direct interventions involving patients, health and relief workers, and administrative interventions for health decision-makers in ministries, hospitals, and health centers, as well as direct technical interventions in the fields of data management, analysis, and services, are examples of such interventions (4).

During a health emergency, aid agencies act quickly, which makes it harder to get emergency information, especially if there isn't a plan. For example, after the terrible earthquake that hit Haiti in 2010, 44 medical teams helped with relief efforts. This doesn't include the field hospitals that came after them in the first 15 days. During the first month of helping, 246 organizations signed up with the Pan American Health Organization (PAHO). In catastrophic situations where the parties, information, and forces are at conflict, it is harder to make the right decision because of the chaos of the

information, the waste that may happen, or the emergence of partial treatment processes that are either ineffective or helpful.

In these situations, it's important to use digital technologies to make the points of entry, analysis, and understanding of the emergency health reality work together (5). Some examples of DHI that have been used during public health emergencies are as below:

Maps and analyses have all the types of data that are needed. Maps help people who make decisions see, understand, and plan their actions in a changing environment. Researchers and health representatives have used maps and mapmaking to study and learn more about chronic diseases like cancer and heart disease, which are on the emergence in both developed and developing countries. No matter if you're looking at an H1N1 graph on the web or a pandemic map from 1694, public health and healthcare use mapping and geographic analysis skills to do their jobs. Health and human services industries use information about the location of people and places. In the past, digital technologies were first used to make maps of patients or people with a certain disease (Table 1).

The information on these maps was limited to the principle of injury, as shown in some of the examples below, and these display panels kept getting better and better until they got to where they are now: digital technologies that show you the information directly, moving and clear, from the location information to the details (6) (See Annex 1).

**Table 1 List Examples of some DHI used in health disasters (7)**

1798	Map of yellow fever in New York City
1821	Map of typhoid fever in New York City
1925	Map of sandfly fever in Peshawar, India
1977	Map of hepatitis in Tasmania
1980	Map of AIDS outbreaks in Ohio and the United States
2002	Map of dengue fever in Pennthur, India
2019	Esri CovidPulse dashboard
2019	Johns Hopkins University dashboard
2019	Us Weekly unemployment data
2020	HeRAMS

mWater, for example, this technology was first used to track the amount and quality of water in Tanzania with help from USAID (See Annex 2). Since then, it has grown a lot in terms of data collection, analysis, screening, and visualization. Now, more than 10,000 digital accounts from 184 countries take part. Because of this, it has now become one of the most used platforms in the world, especially in the WASH sector. This technology is also free, can be changed, is flexible, gets better with time, and anyone can use it (8). The goal of the Health Resources and Services Availability Monitoring System (HeRAMS) Initiative is to make health data quickly accessible to the people who make decisions at the national, regional, and global levels. Its goal is to help countries organize, receive, review, and deliver basic health services and resources to where they are necessary.

It also wants to improve health information systems by making, keeping, regularly updating, and sharing a reliable master list of health facilities. HeRAMS was made for the state of Darfur in Sudan as a way to evaluate health facilities in an area that is hard to get to and where services are often interrupted (9).

## **1.1 Covid-19 Pandemic as a Health Disaster and the Use of Digital Health Technology**

The World Health Organization (WHO) defines public health disasters under the control of a deadly infectious emergency agent as a killer that contributes to people's deaths or causes disease in them, such as a biological accident or epidemic disease, or presents a risk to people's lives and increases their death rates, or causes disease and long-term disability. The Corona pandemic was only a clear example of this, as the world today is more interconnected and more vulnerable to epidemic outbreaks than at any time in history, and the outbreak of the international and regional Corona pandemic is only the most visible example of the dangers of this interdependence in the event of health disasters. It also had an impact on the global economies, which were unable to respond fast and efficiently to the outbreak (10). More than 572 million confirmed instances of coronavirus infection have occurred to far, excluding the deaths of more than 6 million individuals, with more than 12 billion doses of vaccine administered till date (11).

During the Covid-19 pandemic, when the disease spread quickly and there was a lot of need for health care, some systems broke down. This meant turning on the role of digital health to manage big data, the analysis process, and communication interventions, as well as turning on artificial intelligence, techniques, and software, with the goal of making healthcare providers' jobs easier and helping affected people quickly and effectively. During the covid-19 epidemic enhanced communication, analysis and connection of information systems between nations aided in the management of crisis and their subsequent control. From the use of dashboards and mobile phone-based applications for several purposes, from coordination to planning, and then follow-up, digital technologies have assisted healthcare systems, coverage, and service quality. In addition, management of export and medicine distribution, distribution, transfer, and delivery is required. This is in addition to digital health records and follow-up services.

Electronic medical records, improvements in computer sciences, big data management, artificial intelligence-based inventions, health system readiness monitoring systems in the case of a health crisis, including several other improvements are on the way (12).

Many hospitals, for example, have turned to a variety of creative and innovative measures digital health system to safeguard their personnel and effectively handle the national problem. Using thermal cameras to track and measure people's temperatures on the streets, tracking bank purchases of medicines, tracking the injured persons' field movement using Global Positioning System (GPS), tracking the patient's cars and mobile phones, managing the patient's data, tracking travel, isolation procedures, and managing food distribution are all examples of Korean experience.

In addition to managing medicine using healthy digital technologies that locate the patient, it also provide the necessary medicines to carry out preventative and safety measures for health and medical professionals in hospitals/medical facilities as well as to the humanitarian/social workers. As a great example of the digitized hospitals and clinics, the American Hospital in Dubai had converting the 390-bed hotel into a field hospital that cares for people with corona and equipping the building with full information management services for communication, with the exception of the indirect work of administrative staff and communication with digital patients as a telehealth service, or another example from RSN- Lebanon involving the management and follow-up of patients online Telehealth and sending medications and therapeutic supplies (13).

Mobile applications which greatly contributed to the facilitation of a variety of health services for crisis management, whether for patients, health sector workers, decision-makers, security personnel, or other workers in the auxiliary services in the management of water, energy, communications, medicines, food, or logistics services that support the concepts of health in general. Examples: PathCheck SafePlaces Covid Watch in USA, NHS Covid-19 and COVID Symptom Study in UK, Immuni in Italy, Covid Safe in Australia, Trace together in Singapore, Aarogya Setu in India, Tawakkalna and Sehha in Saudi Arabia, and Ma3an in Lebanon (14).

The internet speed and data security, whereas the pandemic forced telecommunications companies to find and develop many technologies to meet people during the pandemic period, and higher services were designed for the medical and press staff to follow up on patients and rationalize communication, such as IoMT services, this is in addition to the development and invention of many dialectical protection techniques for banks and research institutions to enhance protection and e-commerce security (15).

Using technology to track disasters and prepare for them at the international and national level, such as the Live Covid-19 vaccination tracker, HeRAMs, PAHO platforms, and others, which shows the location of the infected, corona testing, communication with patients, vaccination and quarantine, and a lot more information. During the Covid-19 pandemic, the HeRAMS platform contributed to providing a quick picture of the health system, as this platform allows decision-makers to digitally analyze the reality of the health system during the pandemic, allowing determining the needs and capabilities of health, pharmaceutical, human, and infrastructure health facilities within a geographical scope. The unique and fundamental difficulty in this respect is that the information is updated on a regular, rapid, and permanent basis as a result of attaching most health institutions to a single platform that allows for an organized and clear picture of the health realities of this specific location. HeRAMS-Covid-19 dashboards made a significant contribution to crisis management and decision-making for health ministries in Mali, Sudan, and Yemen (16).

## **1.2 Lebanese Health System Overview**

The Lebanese health system has changed throughout time, but it still relies on curative treatment in health centers rather than national primary and preventive care systems, with the private sector controlling the majority of its basic facilities (Figure 1). The majority of healthcare institutions in Lebanon are run by the private sector. In Lebanon, there are 28 government hospitals, 134 private hospitals, 5 university hospitals, 4 of which are private, 213 primary care health centers run by non-governmental organizations in collaboration with the Ministry of Health, 950 clinics and a public health center spread across most of the Lebanese territories, and two-thirds of which are privately owned. Despite their presence, these health centers remain severely understaffed, particularly in terms of basic health services such as laboratory medicine and radiography (17).

The following are some of Lebanon's strengths in health care that we can discuss. The fact that the private and public sectors have been working together for a long time and that the non-governmental sector is very active is an impressive sign of resilience in light of the increased risks caused by the Syrian Crisis. There is a vast network of health services that serve the poorest communities as a result. Seven percent of GDP is now allocated to healthcare costs, with out-of-pocket healthcare spending falling from 60 to 36.4% over the past 17 years. The way health care is paid for in Lebanon is still tilted toward curative tertiary care, and the health information system is still not well organized.

When there is a lot of political chaos at the national level, it is harder to make important health decisions for the whole country and giving some public health tasks to the states is not the best solution. According to the WHO report, the Lebanese health system faces a number of problems. These include encouraging better use of data and proof when making decisions, improving the health information system (HIS), which includes both civil and health data, and coming up with policies and reward systems to keep qualified and skilled staff (18).

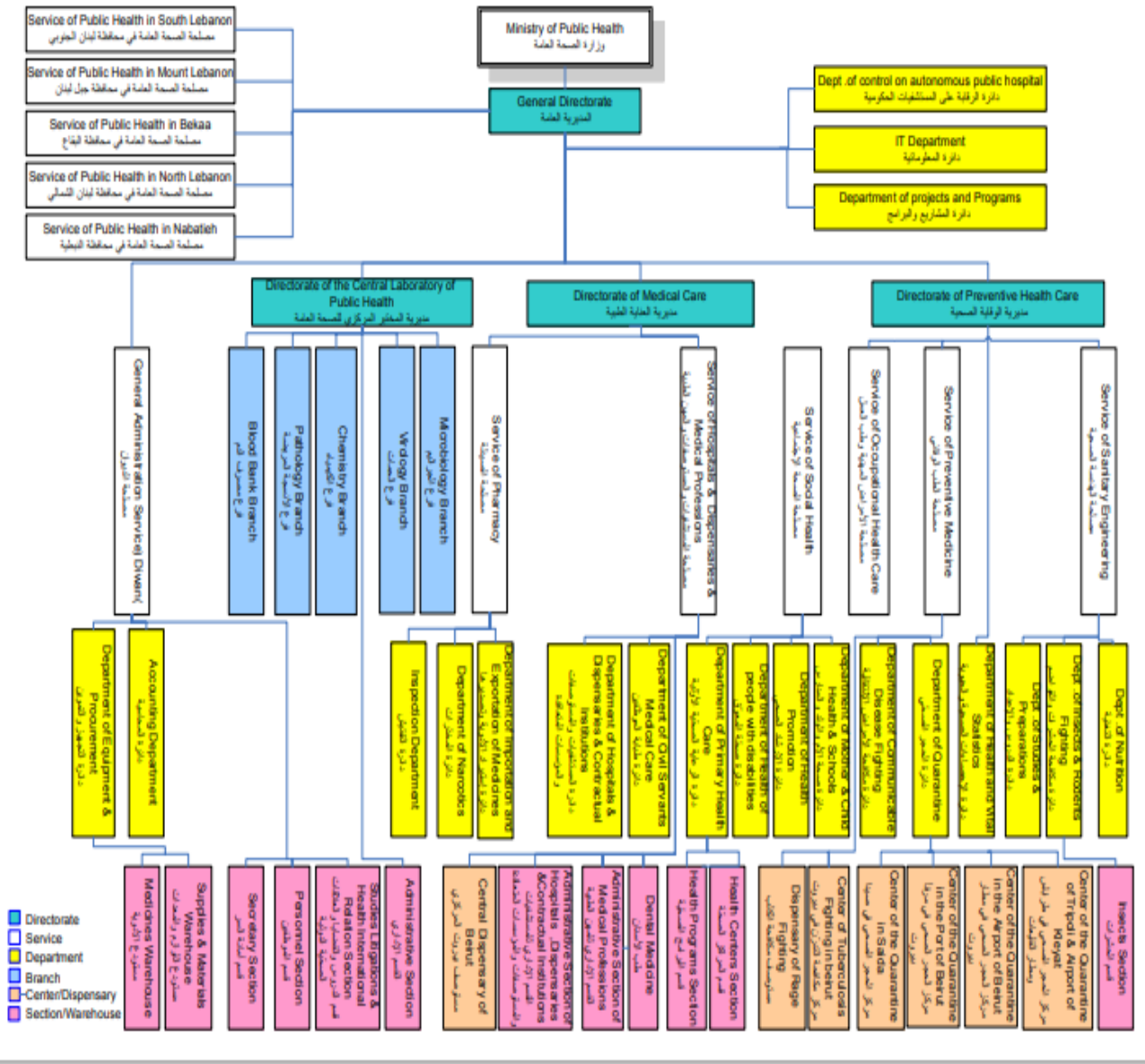


Figure 1 Ministry of Public Health in Lebanon Organigram (19)

## Chapter 2: Problem Statement, Justification, Objectives

### 2.1 Problem Statement and Justification

Multiple technological efforts in Lebanon have been implemented to support the digital health market, especially by the National E-Health Program supported through the Lebanese Ministry of Public Health, 2013. It mainly seeks to technically promote Universal Health Coverage (UHC) through growing the health sector by improving quality standards by using Information and Communication Technology (ICT) (20). In October 2018 “Hôtel-Dieu de France” (HDF), a medical private center in Beirut, became the country's first e-hospital with an integrated Hospital Information System (HIS). This system combines three of the most important parts of a hospital: the patient's complete medical records, files for financial operations, and files for managing human resources.

Since the use of e-health in Lebanon is still low and it is still in its early stages, the switch to e-health is important even though the country isn't fully ready for it. Using e-Health services is very important, and it could change both health outcomes and health indicators. E-Health is important because it can affect both health outcomes and health indicators. In Lebanon, digital health technologies have been used in thirteen out of fourteen hospitals, depending on the type of hospital. It was mostly used in medical services and hospital departments (31 percent). Because of this, thirteen out of the fourteen hospitals now have a department for digital health. Most Digital Health applications are E-documents and are used in front desks (17 percent). Only about 8 percent is used for the operational system to support pharmacies or technically to cover radiology and general labs. Over 90% of patients don't have a digital badge for their medical information because digital cards aren't available everywhere and people can only get limited information on paper. The Lebanese Ministry of Health needs to commit to e-health. This promise must be followed by long-term assistance for implementation, capacity-building, and evaluation efforts that are tied to a national e-health plan (20).

After that, more than 1.5 million Syrian refugees entered Lebanon during the Syrian War, and as a result of social breakup and the incapability of the Lebanese health system to meet all demands, refugees were exposed to serious health problems. Since then, several initiatives have been launched in the field of digital health services to demonstrate the necessity of using these technologies for direct health communication. In order to get or organize health services, particularly in the provision of care services for children or family medicine, or in coordinating their maternity and emergency checkups, with PHCs, international organizations, and local NGOs. Technical efforts have been made to facilitate communication with patients, particularly in health centers that serve people with disabilities, by offering health administrative coordination, and psychological follow-up between therapists and parents specifically in private centers. This was enabled by the fact that a large number of refugees had smartphones, which made it a lot easier to handle and implement digital coordination between the health institutions and the direct beneficiaries.

In Lebanon, public spending on health decreased from over 9.5% in 2005 to around 3.5 % in 2012, then partially increased to reach 4% in 2020. The Ministry of Health established the National Primary Health Center Network (NPHCN) in 1996, which contains 226 primary health care clinics across all Lebanese regions, the majority of which are run by international organizations and private relief



organizations and serve over one million people. Several technical efforts organized this network, especially in 2019, when an electronic health system was established through which these centers are managed and communicated with the Ministry. The weak infrastructure, such as the possibility of securing electricity and the Internet in many villages and rural areas caused many challenges, in addition to the lack of technical expertise, the HR caused many challenges to enhance the E-health services provided by the ministry (20).

Unfortunately, on August 4, 2020, a large chemical blast happened in the port of Beirut, causing the destruction of a large part of the city, as more than 300,000 people were displaced due to the impact of their homes, in addition to the deaths of 220 people, approximately 6,500 injured, and extensive damage to Lebanon's health and vital facilities. Several initiatives in digital health have been launched, most particularly by the World Health Organization, which has implemented an emergency plan after coordinating response efforts. The strategy aimed to reduce the rates of mortality and morbidity among individuals affected by the explosion by providing them with immediate and necessary care.

In this context, the use of digital technology has been made critical in encouraging plan execution, especially during the Covid-19 pandemic. The initiative planned to expand work into monitoring the emergency demands using HeRAMS technology, which enables decision makers to understand the current state of the health system, identify gaps in order to provide suitable health solutions for emergency response.

Lebanon's digital health market is seen as promising; despite the country's economic difficulties, investments in the digital health sector are expected to exceed 87 million US dollars by 2022 (20).

In Lebanon's digital health market, mobile applications, E-Health, telemedicine, health recruiting team apps, hospital health information system, pharmaceuticals digital health initiatives, wellness and fitness apps, and linked wearable devices have received the most investment in the digital health market in Lebanon (20).

There are numerous challenges facing the digital sector, including digital health in Lebanon, the most significant of which is Lebanon's general lack of infrastructure capabilities, such as weak electricity, and massive power shutdowns, in addition to the lack of digital infrastructure such as the Internet and technical extensions, broadband connectivity that contribute to support sustainability of the services.

Weak supported logistical services, maintenance services, insufficient specialist human resources, costly customs processes, insufficient legislation and digital judiciary to investigate cybercrime, as well as a lack of specialized policies and regulations controlling investment.

When the Covid-19 hit Lebanon at the beginning of May 2020, everyone was in a state of panic, as the number of infected in the Lebanese arena expanded, turmoil spread through different information platforms, lab results that didn't match up, the prices of medicines that were needed during the crisis and the distribution process in the regions and health facilities (21), chaos in prisons (22), and government decisions, which prompted the Lebanese media to announce a complete closure in the country instead of the Ministry of Health or the Ministry of Interior on March 12, 2020, followed by the official ministries (23) which was then followed by chaos in the management of vaccines at the country level as well (24).

The health information chaos is extremely hazardous to human health and may harm life, especially if the wrong decision is made based on this information. The hazards of information come from its design structure, whether it is incomplete, incorrect, supplied by several sources, fragmented and conflicting, or redundant or incomplete. As a result, decision-makers and patients are always in danger of making the wrong decision, putting the safety of patients or infected persons at risk (25).

Even though there was chaos and confusing information, many electronic crisis management platforms were used during this pandemic. However, the chaos didn't go away, especially when compared to the many countries that handled the Corona crisis well, like Yemen, which has a unified organization like WHO's HeRAMS system (26). Consider that the problem is caused by a large number of platforms that aren't coordinated. In addition to the suggestions of some Lebanese research centers, which call for an evaluation of the digital health situation at the level of the Lebanese state for the purpose of harmonization and integration (27).

After discussing the complexity surrounding Lebanon's digital health platforms, several questions should be raised, such as: How can we interpret and assess the shared data with the public during the pandemic? How can we detect gaps in this shared information? How can we develop or suggest a digital health policy in Lebanon?

The specific aim of this study is to answer the following questions:

## **2.2 Objectives**

### **General Objectives:**

Assess the shared digital health data with the public during the Covid-19 pandemic in Lebanon, and make recommendations to health decision-makers regarding the establishment of a digital health policy.

### **Specific Objectives:**

1. To identify the shared digital health data with the public during the covid-19 in Lebanon.
2. To assess the shared Covid-19 digital health data using a data service framework to identify standards alignment and gaps.
3. To provide health decision-makers with recommendations that will contribute in establishing a digital health policy in Lebanon.

## Chapter 3: Methodology

### 3.1 Study Type

Literature review based on research papers published on the ‘use of shared data in health disasters especially in the COVID-19 period in Lebanon’, the shared information by Lebanese dashboards through the WHO, Lebanese Red Cross, Ministry of Public Health in Lebanon, government and private hospitals.

All the research papers were searched using Vrije Universiteit Online Library, Knowledge to Policy Center at the American University of Beirut, The Faculty of Public Health - Lebanese University, ResearchGate, WHO reports and website, BMC research gate etc. Most of the published information was available in English and some in Arabic language. All the accessed papers have been published during the past ten year (specifically after the outbreak of Covid-19 pandemic).

### 3.2 Study Area

We focused on the Covid-19 pandemic that occurred in Lebanon (Figure 2). We used data published by several digital health platforms during the pandemic, during the time period of March 2020 to June 2021. Most of these platforms were used to study the infected people in all Lebanese cities. In addition to that, these platforms through their websites, dashboards and mobile applications shared more medical information about the availability of the hospitals and public health centers, the kind of services that are available, and the availability of the medical workforces. Some of these applications are organized by the Lebanese ministry of public health, and some by international non-governmental organizations (NGOs), local NGOs, and some private hospitals and universities. Several platforms and applications have been used during this period. Explicitly, eight platforms were selected to analyse data in our study. These platforms were the most useful sources of information in Lebanon during the pandemic period. Decision makers got their information mostly from these platforms. Moreover public media, journals, and all news providers relied on these platforms to share the health related information in the country.



**Figure 2 Map of Lebanon (28)**

The main goal to select these Lebanese platforms was to share data on the status of the Covid-19, emergencies status and circulations, geolocation of the infected people, location of the healthcare providers, medication providers, and much more. All these platforms were openly available for the public. So, each resident could access information through these websites and mobile applications. Most of these platforms used to update their information on a daily basis during the pandemic period, and some of them had a live update option as well. These sources reflected the change in numbers of infected persons per hour, locations of the infected persons, drugs dispensing centers, price list of drugs, nearest hospitals to the patient, awareness sessions, complaints and readily available human resources.

To assess the shared digital health data during the Covid-19 pandemic in Lebanon, using a health data services approach helped us to identify the gaps in these data platforms compared to the selected framework by the WHO classification of digital health intervention. This led us to understand the gaps, describe them and also facilitated us in framing recommendations for building a strong digital health data strategy to help the Lebanese health managers and decision makers under critical circumstances.

### **3.3 Recruitment, Data Category and Data Collection Method**

In this study, information was collected from eight digital health platforms that showed important emergency health data about patients with the Covid-19, which helped health manager and decision maker to make a direct action to rescue and help infected patient.

During the Covid period in Lebanon, the media extensively depended on the several avenues (as described in the earlier section), as well as on the digital health platforms run by the Ministry of Public Health to disseminate information about this illness and how it spread. Despite being diverse, these platforms were the most interactive source for individuals and for majority of people, these platforms served as their initial point of reference. To regulate the smooth flow of information and to reduce chaos, these were also recognized through the Lebanese Ministry of Information and a website connected to the Ministry of Health website (28). The information was collected from 8 digital health platforms in Lebanon viz., the Lebanon National Operations Room (MOPH), Ma3an Application, WHO Lebanon, Lebanese Red Cross, AUBMC, LAUMC, Hotel Dieu de France and Impact (Covax platform) (Table 2) (See Annexes 3, 4, 5, 6, 7, 8 and 9).

To understand the method of data collection from the selected platforms, a sample classification has been prepared, which includes information about each platform's name, how frequently it is used, whether it is related to the Covid-19 period, what technology tools it encompass (website or application), what type of intervention it adds to, the basic components of this data, and what information it publishes.

**Table 2 Eight shared digital health data platforms of Lebanon**

Data Category							
S.No.	Shared Digital Health data with the public in Lebanon (during the Covid-19 Period)	In Routine Period	In Covid-19 Pandemic	Technology Category	Interventions	Main Features	Info shared by
1.	<b>Lebanon National Operations Room</b>		X	Website	Data sharing	Numbers, demographic and national health status	Dashboard PDF reports
2.	<b>WHO Lebanon Daily Brief</b>		X	Website	Data sharing	Numbers, demographic and national health status	Dashboard PDF reports
3.	<b>Lebanese Red Cross (LRC) Platform</b>		X	Website	Data sharing	Numbers, demographic and national health status, numbers of available workforce in emergencies.	Dashboard PDF reports
4.	<b>AUBMC</b>		X	Website	Data sharing	Numbers, demographic and national health status	Dashboard PDF reports
5.	<b>Hotel Dieu de France</b>		X	Website	Data sharing	Numbers, demographic and national health status	Dashboard PDF reports
6.	<b>LAUMC</b>		X	Website	Data sharing	Numbers, demographic and national health status	Dashboard PDF reports
7.	<b>Ma3an by TedMOB</b>	X	X	Mobile Application and Website	Tracking Data sharing, communicating with MoPH	Numbers, demographic and national health status, drugs dispensing centers, drugs price list, complaints, video channel, locate nearest hospital, lasted news.	Mobile Application

8.	<b>IMPACT (Covax)</b>	X	X	Mobile Application and Website	Data sharing, Organizing Vaccination Services	Organize communication between the patients and Medical Centers, and can get digital vaccination certificate	Mobile application, PDF reports
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### 3.4 Data Processing, Analysis and Dissemination of the Findings

The information was obtained via contacting the organizations that share out this information, some of which are already accessible online. Some of the software applications utilized during the Covid-19 period are freely available to everyone and can be found in Google Play Store. To access all the information provided by the Ministry of Health or private institutions in Lebanon regarding Covid-19, one need to download it from Smartphone using a Lebanese SIM card.

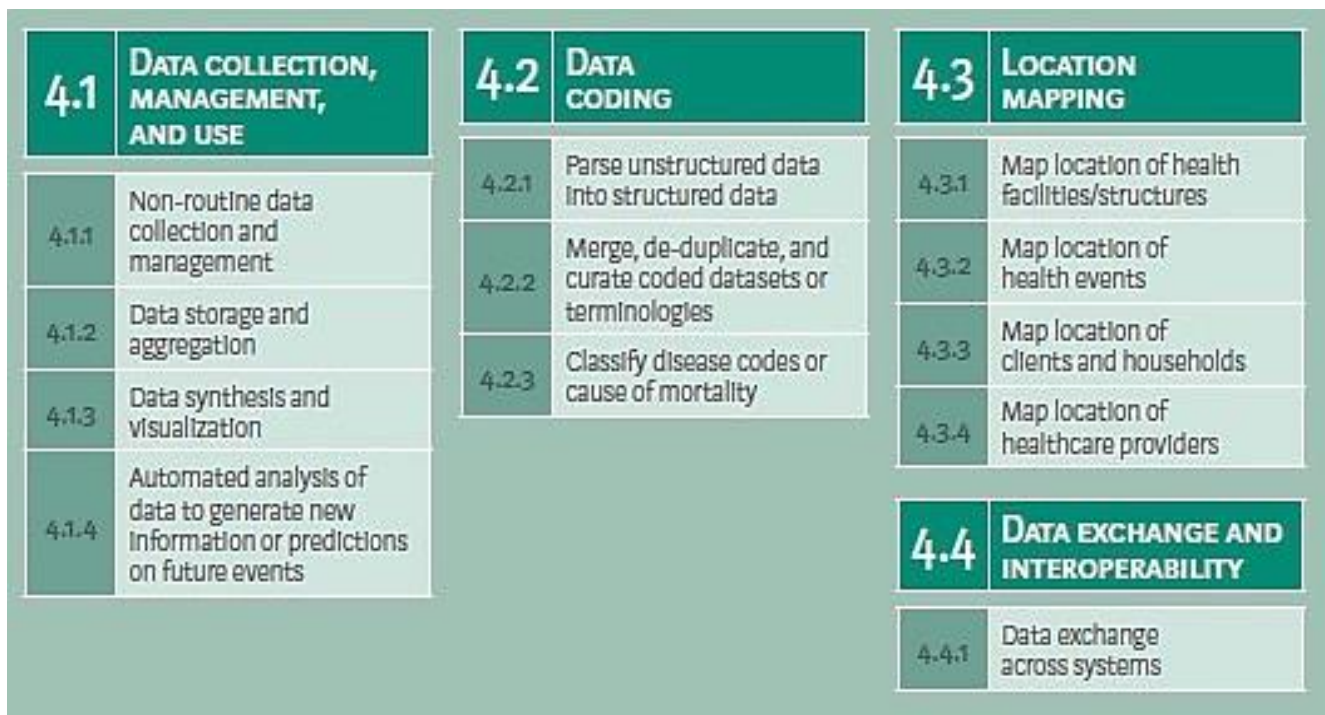
These institutions disseminated health recommendations and occasionally emergency updates via apps and websites to the public in order to prevent infection, record everyone in schools and other public areas, especially children and teenagers, or to inform people of the need to close down certain facilities or the possibility of receiving services in hospitals/health centers. A platform was created for the delivery of vaccines and the coordination of special appointments between hospitals and patients.

Current study is an endeavour to fully understand the Covid-19 situation in Lebanon, its spread, how public and private institutions responded to the pandemic, and how some aspect of digital health technologies was used to spread information, raise awareness, send alerts, facilitate communication between patients and health centers, and determine the availability of medications in the context of a severe economic crisis. From this perspective, this thesis will explore these digital tools and assess how helpful they are to support decision-making by comparing them with the standard health systems.

### 3.5 Analytical Framework

We analyzed and rated the relevant information according to the classification shared by the World Health Organization (WHO) on the digital health interventions which is designed in several frameworks such as clients, healthcare providers, health system managers and data services. By classifying interventions, as well as how digital platforms and mobile phones operate and interact, this approach helps to serve the needs of the health system. It provides administrative, analytical, and technical support to all public health professionals and decision-makers to develop improved planning, organization, coordination, and to enact control. The utilization of digital health interventions is seen to be one of the greatest ways to help the global health sector achieve its goals.

Using this framework, we can obtain knowledge of the key components that comprise any well-balanced and all-encompassing health-care system. These fundamental aspects include both tactical and strategic fundamentals, and it's focused on the information systems management, as well as fundamental inputs. Using this framework's components to evaluate the digital health data activities, researchers will be able to evaluate the process of the data collection and its classification from the data collection management and use, to the data coding, location mapping, and of course the data exchange and interoperability. The main timeline scale was during the Covid-19 pandemic. This was used as a reference to examine core needs and compare them to the basic requirements defined by this framework, as well as identified the gaps in the shared data by comparing it to the four blocks of the data service framework published by WHO in 2017 (Figure 3 and Table 3).



**Figure 3 The Data Services Framework (4.0), Classification of Digital Health Interventions (29)**

**Table 3 Definitions of the four blocks of Data Services Framework**

<b>The four blocks of Data Services Framework</b>	<b>Definitions</b>
<b>Data Collection, Management and Use</b>	It includes managing the entire digital process, which includes collecting data, classifying it, and then evaluating it in various ways before storing it in ordered ways that ensure safety from interference. This goes beyond simply being able to visualize and arrange data in a way that any data system can support supply chains.
<b>Data Coding</b>	In addition to organizing encrypted terms and removing duplication and conflicting information, which includes standards management of the data coding and digital plans, which in turn aims to analyze unorganized data and arrange it through processes that make it structured data. in addition to showing data on diseases, injuries, or the number of deaths due to specific infections such Covid-19.
<b>Location Mapping</b>	This refers to the use and management of coordinates, determining the geographic location of a hospital or medical facility, a site for individuals with a particular health condition, a special site for healthcare professionals or regular clients of particular facilities, as well as the process of information sharing between facilities.
<b>Data Exchange and Interoperability</b>	It is in the design of protocols that help two or more systems communicate and exchange health information, permitting us to eventually develop a new system or harmony that produces accurate and helpful information.

We focused on the fourth block i.e., “data services” framework to analyze the publically shared Covid-19 data during the pandemic in Lebanon and analyzed how the upcoming digital health data platforms provided information that really help decision makers to devise policies.



## Chapter 4: Study Results and Findings

### 4.1 Covid-19 Pandemic in Lebanon

The first wave of the Corona pandemic hit Lebanon in February 2020, at a time when the country was experiencing severe political breakdown. At that point of time, protests were being held on every street in Lebanon, followed by the beginning of the financial and economic collapse, and then by the explosion of the Beirut port, on top of the crisis of 1.5 million refugees left by the Syrian war. All of these catastrophes affected Lebanon's health-care system. Data from the first year of the outbreak demonstrated that closure alone is ineffective in lowering infections. Strengthening health capacity and readiness, guaranteeing immunization processes, and improving the health system's reaction and efficacy, all contributed to the decrease in Covid impact and spread.

After the death of the first case of corona on March 10, 2020, a solid plan was made to close most amenities at the country level, especially after WHO announced that Lebanon has entered the third stage of transmission. Since the number of PCR (Polymerase Chain Reaction) examinations and tests were limited at the country level, the average daily cases of the infected reached about 16 people between March 15 and April 17, 2020.

Following the drop in cases, procedures were eased and the airports were reopened on July 1, 2020, with a positive infection rate that did not exceed 5 percent, until the explosion of the Port of Beirut, which killed 220 people, injured 6,500, and damaged more than 300,000 homes, excluding the damage to many Corona follow-up centers and the destruction of some hospitals in Beirut.

During the relief operation, hospitals were overcrowded with infected people, patients and injured, resulting in a large outbreak of the virus and the country's entry into the third wave of Corona on September 15, 2020, when the number of infected people exceeded 1,000 cases per day, or about 13.9 percent, which equals 159.4 cases per day per 1 million/person. The pandemic was later controlled and the vaccine was gradually introduced to reach the population (30). Nowadays, the people vaccinated rate in Lebanon per the percentage of population is 40.07% which is about 2,712,261 persons (31).

### 4.2 Digital Health Situation in Lebanon

‘The rapid transition from routine health services to digital health services may be difficult at the moment, but it must happen one day’, as the Lebanese Minister of Health declared in 2018 at a special conference for Information and Communication Technology (ICT), and presented in his speech that rural areas still lack basic health services, electronic services, in addition to logistical weaknesses. He highlighted the significance of this step in the development of Lebanon's health and economic systems (32).

The Lebanese Ministry of Health's ‘National E-Health Program’ aims to improve hospital health information systems, health information management, connect all hospitals and health centers to the Ministry of Health, establish a unified health information network, develop mobile applications, and design it to serve both health workers and patients.

The Lebanese Republic's level aims (a) creating a computerized system for monitoring the medicine process and sending it to Lebanon's hospitals, (b) developing telemedicine services that would allow patients to follow up on their files with their doctors online and communicate with them at a minimal cost, (c) creating e-health education for Lebanese health personnel that promotes quality and continuity of learning, (d) developing ethical standards and electronic principles that safeguard health and medical data and maintain its privacy between hospitals and health centers, as well as (e) establishing worldwide collaborations with large information organizations and enterprises to secure the sector's future development (33). Furthermore, the impact of developing a digital health system will benefit the poor, who will be able to get free electronic services and health follow-up through coordination with their physicians and government hospitals via text and voice messages, resulting in significant cost savings (34).

In addition, several digital health platforms in Lebanon have been used in international initiatives to provide assistance to Syrian refugees. For example, the provision of electronic apps to promote prenatal health (35) and the measuring of depression levels among Lebanese citizens and refugees (36) are both examples of how these platforms have been put to use. They will then design digital interventions for social psychological help in the form of applications on Smartphones.

In light of the fact that around ten start-up companies are now operating in Lebanon within the sector of digital health, those companies are working towards the goal of opening new markets for themselves inside the country. As of now in the year 2022, it is predicted that the revenues of the digital health industry in Lebanon are about 156.20 million dollars, and it is anticipated that these figures and profits will rise by roughly 14 percent in the year 2027 (37).

### **4.3 The Digital Health Initiatives in Lebanon during Covid-19 Pandemic**

Several digital health platforms were used in Lebanon during the Covid-19. Our study concentrated on initiatives related to the image of the health system and map tracking. These techniques assisted decision makers when making decisions on relief or assistance, developing a response strategy, or engaging directly in the field of health.

These platforms comprised a platform provided by the Lebanese Ministry of Health, the Lebanese Red Cross, a platform issued by the World Health Organization, a platform issued by various public and private hospitals, and a tracking application built for mobile phones.

The following information describes the most prevalent Lebanese digital health platforms utilized in routine or in Covid-19:

#### **4.3.1 Lebanon National Operations Room/ Ministry of Public Health in Lebanon (LNOR)**

This platform, which originated from an operations room that gathered all the necessary data from the Ministry's various regional branches, which in turn collected data from all hospitals and Primary Health Centers (PHCs) in various areas. It was considered to be the main platform for the Lebanese Ministry of Health in distributing information related to Covid-19 from the beginning of the pandemic until its decrease in July 2021. This platform provides a daily data report on Covid-19 including:

Infected cases in locals, infected cases in expats, recoveries, deaths, total registered cases in the past 24 hours, conducted PCR tests in labs since 48 hours, home isolations, current cases in hospitals, mild cases, ICU cases, chronology of decisions according to number of cases, distribution of cases by nationalities, geographic location of reserved hospitals, distribution by gender, distribution by age, distribution by governorates, number cases by location, action taken at the governorate and municipal level, role of ministries and NGOs.

Through this platform one can also find the number of the total cases, total deaths, new cases, the cases appear on the Lebanese map, mild %, Asymptomatic %, Severe and critical %, cases by gender, cases by age, exposure, case by date, cases by district of residence (38).

#### **4.3.2 WHO Lebanon Daily Dashboard**

When the first corona case surfaced in Lebanon on January 3, 2020, work on this platform started, and it continues till today. For instance, it was discovered that 1,220,560 patients were infected in the most recent upgrade of this platform. In addition to documenting approximately 10,740 deaths until last update on this platform which surfaced on November 19, 2022.

Up to present, 5,809,032 doses of the vaccinations have been delivered. In this platform, one finds the cases by age group, cases by source of exposure, cases by clinical presentation, distribution of fatalities by age group, cases by the district of residence, number of cases, deaths, cumulative number of cases, new cases, recoveries, and health workers (39).

#### **4.3.3 Lebanese Red Cross (LRC) Platform**

Information on the movement of paramedics during the epidemic was exclusively published through this digital platform. For example, this private local NGO has handled the transfer of more than 3,693 patients with proven infections, since the beginning of the epidemic.

This platform also published on a daily basis the number of patients who were infected in the various Lebanese regions, along with preventive statistics, the number of paramedics who conduct volunteer operations every day, and the scope of their readiness and ability to respond.

Additionally, later on, blood donations and vaccine campaigns have been also managed by this platform. Since the Lebanese Red Cross is a private organization and the country's largest ambulatory institution, it is one of the first to adopt the management of digital health platforms during the Covid-19 period. In this platform a daily updated data had been shared, such as confirmed cases in Lebanon, confirmed recoveries, confirmed deaths, transported cases till date, and Lebanese Red Cross human resources preparedness (40).

#### **4.3.4 Hospitals Shared Data**

Basic information on the sickness was released and linked to the state of the hospital through the digital health platforms of Lebanon's main hospitals. The American University of Beirut Hospital, one of the biggest hospitals in Lebanon, for instance, frequently posted information about the number

of positive cases it received, the number of deaths, and the number of recovered patients, on its website. These statistics were derived from daily activity and operations of the hospital.

Regarding Hotel Dieu University Hospital, a hospital associated with Saint-Joseph University in Lebanon, the majority of the information has been provided on the hospital's website, including the hospital's capacity, the number of positive cases received, the number of deaths, the numbers of Covid-19 tests, and other information highlighting the hospital's state over the process of the two weeks.

For the Lebanese American University Hospital, the hospital's website is used to publish more data regarding the gender of patients, as well as their percentage, in addition to regular information on the movement of Covid patients. Furthermore, the big hospitals in Lebanon such as AUBMC, Hotel Dieu de France, LAUMC, and much more shared the daily data like the cumulative numbers tested since last 48 hours, daily positive tested, daily negative, and patients in the hospital (41, 42, 43, and 44).

#### **4.3.5 Ma3an" Together Against Corona**

The platform's main objective, according to the Ministry of Health's definition, is to raise the level of health promotion in Lebanon through educational processes, health awareness campaigns, and digital communication programs, that aim to connect institutions with each other in order to obtain good coordination and accurate information. At the start of the crisis, the Ministry of Health created the "Ma3an" platform, which means "we are all together" in Arabic. On July 16, 2020, the Ministry of Health launched it in collaboration with the American University of Beirut, and it was made available to all citizens via the Apple and Google Play Stores.

One only needs to install it. Enter the data, communicate, and activate Bluetooth, if the person is in a public place, while waiting for the Covid examination result. If your case appears to be positive, it sends an alert to you and those nearby within a certain diameter. Data is collected using an encoded identity, the information of the virus-infected person is uploaded to his file, and he/she can obtain digital reports, whether by examining the first positive, examining the second negative, which is then submitted by hospitals and health centers to the Ministry of Health, which then enters the information for each account (45).

#### **4.3.6 Impact "COVAX"**

The COVAX platform is the result of the COVID-19 Vaccines Global Access (COVAX) program, which is managed by a number of partners, including the World Health Organization, United Nations International Children's Emergency Fund (UNICEF), and Coalition for Epidemic Preparedness Innovations (CEPI). In Lebanon, the COVAX platform was managed by IMPACT, which aimed to organize the process of distributing PCR tests and managing the distribution of vaccines for Covid. This platform was remarkable for linking all Lebanese hospitals and health centers with the Ministry of Health, and the entire process was managed electronically.

The process begins with the Ministry of Health's announcement regarding the availability of vaccine. The user creates his own account, enters all of his personal data, and then selects the nearest health center, and procures the vaccine. Following that, a digital code is generated, which serves as a vaccination certificate for the user via the health application.

## 4.4 The Usage of the Selected Framework

In order to identify the extent of the information that has been disclosed in comparison to the indicated framework, we conducted an analysis of the data provided by eight different digital health platforms, utilizing four different blocks of analysis and twelve different factors (Figure 4).

### 4.4.1 Data Collection, Management and Use

In the subject of collecting, maintaining and using information, most of the platforms that have been identified depend on collecting information directly, through medical centers and hospitals, and it is examined either manually or electronically through work teams. As for the mechanism of keeping data, each platform has its own collection using web-based servers, with a number of them later developed as applications such Ma3an and Covax.

**Non-routine data collection and management:** Through paper data collection and digital data collection. Many medical institutions in Lebanon began collecting data on paper, especially in the rural area of the country, before the development of E-Surveys to collect data via websites, KOBO, and mobile surveys such as OpenDataIt (ODK), FormHub, mHBB and others.

4.0 DATA SERVICES		
CATEGORY	INTERVENTIONS	SYNONYMS
<b>4.1</b> <b>DATA COLLECTION, MANAGEMENT, AND USE</b> Digital approaches to data collection, management, analysis, storage. This can include standalone interventions focusing exclusively on data collection and management, as well as data services to support other interventions, such as data visualization within supply chain management.	4.1.1 Non-routine data collection and management	- Electronic data collection, digital data collection - Mobile based surveys, using applications such as OpenDataKit (ODK), Enketo, FormHub, etc
	4.1.2 Data storage and aggregation	- Data warehouse, repository
	4.1.3 Data synthesis and visualizations	- Reporting dashboards, report generation - Presentations of data - Business intelligence
	4.1.4 Automated analysis of data to generate new information or predictions on future events	- Predictive analytics - Machine learning - Artificial intelligence
<b>4.2</b> <b>DATA CODING</b> Digital approaches to code data and manage the use of standardized datasets.	4.2.1 Parse unstructured data into structured data	- Dirty data management - Automated data cleaning
	4.2.2 Merge, de-duplicate and curate coded datasets or terminologies	- Maintenance and versioning of health informatics terminology standards - Terminology services - Semantic interoperability
	4.2.3 Classify disease codes and cause of mortality	- Recording cause of death - ICD coding, clinical coding for reporting and insurance - Mapping local terminology, codes, and formats
<b>4.3</b> <b>LOCATION MAPPING</b> The use of geolocation coordinates to map objects and events.	4.3.1 Map location of health facilities/ structures	- Global Positioning System (GPS) mapping
	4.3.2 Map location of health event	- Geospatial visualization - GPS mapping
	4.3.3 Map location of clients and households	- Demarcation of catchment areas - Mapping coverage areas - Geospatial visualization - GPS mapping
	4.3.4 Map location of healthcare providers	- Mapping of health worker route to track the services provided
<b>4.4</b> <b>DATA EXCHANGE AND INTEROPERABILITY</b> The capability of two or more systems to communicate and exchange data through specified data formats and communication protocols. [6]	4.4.1 Data exchange across systems	- Data mediation - Interoperability and accessibility - Information exchange - Interoperability layer - Data orchestration

Figure 4 Data Services Framework (4.0) (30)

**Data storage and aggregation:** Data warehouse is interactive software, such as Covax, that enables users to access their own medical data, input their own medical data, and receive response from their physicians or medical institution, such as a vaccination certificate or medical prescription.

**Data Synthesis and visualization:** Through the utilization of reporting dashboards, graphs that effectively display the information, and presentations of data that are efficient. The number of infected people and deaths per region or per hospital, as well as a wealth of other information including the number of daily PCRs, the capacity of hospitals and the readiness percentage for paramedic staff are displayed on all of our platforms through the use of these types and visualizations. A comprehensive visualization was obtained from the eight platforms that were chosen.

**Automated analysis of data to generate new information or predictions on future events:** It is believed that predictive analytics is still in its early years in Lebanon. As a result, the performance of predictive analytics in relation to the information that we selected was substandard. As a direct consequence of this, we were unable to find any evidence of predictive analytics in any of the data that we analyzed. The same may be said for both artificial intelligence and machine learning.

#### 4.4.2 Data Coding

The coding of the Covid-19 data and the establishment of connections between it and health providers may be facilitated by the development of health digital systems with the use of standardized datasets.

**Parse unstructured data into structured data:** It is the process of cleaning the data, which was monitored by each application's team in order to ensure that the data is collected accurately and avoid data duplication.

**Merge, de-duplicate, and curate coded datasets or terminologies:** The maintenance and version control of healthcare information terminology standards have been implemented especially by the shared data who received their main resources from different areas in the country such as LNOR, LRC, WHOL and Ma3an and Covax, and the same for the terminology of the services.

**Classify disease codes or cause of mortality:** The majority of the data mentioned show the cause of death, which is the Covid-19, and the technical direct report with their clinical code. Both of these were reported to insurance companies and authorities in Lebanon. Additionally, the necessary mapping that shows the location of the deaths in the country's areas is included.

#### 4.4.3 Location Mapping

**Map location of health facilities/structures:** Through the use of the Global Positioning System (GPS), except for private hospitals, which do not utilize GPS to locate their consumers, this capability was included in the majority of the platforms that we used in our research. This information was available on Ma3an, Covax, LNOR, LRC, and WHOL.

**Map location of health events:** In addition to the Covax application, which displays a map of hospitals and medical institutions that provide PCR and Covid-19 vaccinations as well as other related medical services to infected patients, the Ma3an application displays the map location of a health event managed by Lebanon's Ministry of Public Health, or the circulation shared by the Health Minister, or the Covid-19 operation room.

**Map location of clients and households:** It is a factor that determines the presence of customers or patients in a particular location, and it can be also determined through the use of GPS and its ability to analyze data to become visible. Using such data, we can notify the increase of these cases through the cumulative increase that can appear in one particular location only. This is precisely what occurred with the solutions we selected, such as the "Ma3an" technology, which was designed to aid professionals and health administrators to monitor the Covid-19 catchment areas in Lebanon.

**Map location of healthcare providers:** It is an information analysis that shows us the hospital's location or the health center's place that supplied the service. This was visible in the two Covax platforms (that were placed in both the hospital and the health center) that offered the service accurately. It is able to deliver services, and there are specifics relating to digital data that contribute to the improvement of the patient's condition.

#### 4.4.4 Data Exchange and Interoperability

**Data exchange across systems:** It is the capacity to connect two information systems and analyze information through the exchange of data and protocols development. This technology has been implemented in Lebanon based on the OpenHIM principle, which links and organizes government information through the network of primary health centers. However, it should be noted that the selected technologies, particularly Ma3an and COVAX have similar systems for translating data between systems and medical institutions.

### 4.5 Data Analysis and Results

#### 4.5.1 General Summary

The following table was used to compare the digital data provided by Lebanon throughout the Covid-19 period to the framework of Data Service standards specified by the World Health Organization and categorized in accordance with the classification of digital health interventions (Table 4). This framework aims to support health system needs and develop a language that health program administrators and outcomes can understand. Assigned a classification from (1 to 5) to represent the proportion of existence of this characteristic from our perspective, with (1) being the lowest degree of presence and (5) the maximum. As for non-existence, we indicated it with (x), where "existence percentage" refers to the existence of the needed data via the shared reports used in this study, compared with the data service framework.

**Table 4 Framework of data services of COVID-19 data of Lebanon**

4.0	Data Services	Data Platforms							
		LNOR	LRC	WHOL	AUBMC	LAUMC	HDF	Ma3an	COVAX
<b>4.1 Data Collection, Management, and Use</b>									
4.1.1	Non-routine data collection and management	3	3	4	3	3	3	3	3
4.1.2	Data storage and aggregation	3	3	3	3	3	3	3	3
4.1.3	Data Synthesis and visualization	4	4	4	3	3	3	4	4
4.1.4	Automated								

	analysis of data to generate new information or predictions on future events	2	X	3	X	X	X	4	4
<b>4.2</b>	<b>Data Coding</b>								
<b>4.2.1</b>	Parse unstructured data into structured data	4	4	4	4	4	4	4	4
<b>4.2.2</b>	Merge, de-duplicate, and curate coded datasets or terminologies	3	3	3	X	X	X	3	3
<b>4.2.3</b>	Classify disease codes or cause of mortality	4	3	4	2	2	2	4	4
<b>4.3</b>	<b>Location mapping</b>								
<b>4.3.1</b>	Map location of health facilities/ structures	4	2	2	2	2	2	4	4
<b>4.3.2</b>	Map location of health events	X	3	X	2	2	2	4	4
<b>4.3.3</b>	Map location of clients and households	X	X	X	3	3	3	3	X
<b>4.3.4</b>	Map location of healthcare providers	X	X	X	2	2	2	4	4
<b>4.4</b>	<b>Data exchange and interoperability</b>								
<b>4.4.1</b>	Data exchange across systems	3	3	3	X	X	X	X	X
<b>TOTAL/60</b>		<b>LNOR</b>	<b>LRC</b>	<b>WHOL</b>	<b>AUBMC</b>	<b>LAUMC</b>	<b>HDF</b>	<b>Ma3an</b>	<b>COVAX</b>
		30	28	30	24	24	24	40	37
<b>Existence Percentage</b>		50%	46.6%	50%	40%	40%	40%	66.6%	61.6%

After presenting the analysis table, which is based on a comparison with the standards required for the quality of digital health data, we will now discuss these results, as we are able to comprehend the gaps and their reasons, which will be then used to formulate recommendations for establishing a strong digital health policy in Lebanon.



## Chapter 5: Discussion

### 5.1 General Observations

The main objective of the current study is to assess the publically shared digital health data in Lebanon during the Covid-19 pandemic. The study concentrated on the data that has been made available to the general public and analyzed the eight data dashboards operative in Lebanon, using twelve standards established by the data services framework.

These criteria allowed us to study and evaluate the extent of data declaration in Lebanon to what is known in terms of standards. Consider the information made available to the general public through platforms such as LNOR, LRC, WHOL, Ma3an, and Covax. Data related to private institutions were only limited to the status of these private institutions, and they achieved 40% compared to the standards, and we cannot compare them with information that shows the general status of Covid-19 on a national level, but these shared data were available to the public during the pandemic. The results indicated the amount of limitation of this information in platforms. For example, LRC platform data had limited existence as compared to the recommended standards and took a rate of 46.6%, as opposed to the two platforms LNOR and LNOR, which only achieved 50% of the required requirements. The two most popular applications in Lebanon, Covax and Ma3an, received the greatest percentages viz., 61.6% and 66.6%, respectively.

Although there is a significant lack of data in general, comparing it via the data services framework, categories, intervention and synonyms which aids in highlighting five main findings, due to the low rates in the first and second categories, the study drew three major conclusions, including: (a) Lack of data interoperability during data collection, (b) lack of data cleaning and analysis completion, and (c) the inadequacy of the published data. The third category with that rate led us to notify that there is an inaccurate determination of geographical location, whether at the level of infected cases or health service delivery sites. The fourth category leads the study to indicate a lack of cooperation between the Ministries of Health and Communications since neither the centers nor the data are interlinked.

#### **Lack of data interoperability during data collection:**

Health information is a sensitive issue, especially when it comes to collecting, accessing, and analyzing it safely and confidentially, as well as distributing it safely and securely, whether with the patient or health professionals. As a result, a lack of complete and correct information leads to a lack of interoperability, which leads to the misunderstanding of the data, whether at the individual or phenomenon level, resulting in the wrong and potentially costly decisions. In terms of data quality, it will thus contribute to better coordination of health care, as proper access to data enables decision-makers to make sensitive decisions, such as the decision to close facilities in Lebanon, which was made due to a significant increase in infected cases in some specific areas. Such decisions have an impact on the social, economic, education of the people in this region; therefore making the wrong decision can be extremely costly, if it is based on inaccurate, incomplete, or incorrect data (46).

This is precisely what occurred when some media articles questioned the accuracy of data delivered via digital health platforms. Especially, when laboratory test results are compared to infection rates and mortality rates that is why health experts and epidemiologists have questioned the necessity to review the supplied information, as there is a perception that it is inaccurate (47).

### **Lack of data cleaning and analysis completion:**

Data cleaning presents numerous issues. It appears as soon as we collect general data, and then we begin the process of merging data between existing large data sources. Merging data is the most difficult process due to several factors, the most prominent of which is the problem of information accuracy, for example, as patients' names do not match. It is a significant and serious impediment in the data sets of the same region. This occurs frequently, especially given the ongoing difficulties associated with translating the name from Arabic to English or French.

Check the data for accuracy. Data validation is a big concern for digital health personnel and is generally the focus of the digital health data collection system, which requires them to manually go through the data and catch up on all the faults they find. Furthermore, they examine the data using simple paper tables, as we find in many health clinics and hospitals around Lebanon (49).

Data extraction from PDF reports is crucial in development analytics due to the vast volume of past records, particularly which are obtained from public hospitals in the form of PDF reports. This is challenging not just because the numbers are difficult to extract, but also because the numbers are organized in various ways as the information becomes jumbled up in the report text. Putting figures into context is challenging, resulting in many hours spent validating extraction (50).

### **The published data are inadequate:**

Human error and the old way of data entry especially manual, unclear policies on the data collection process, duplication of the health data, different official languages between ministries and public or private sector especially in the data reports, are main reasons for inadequate data.

This is exactly what happened in Lebanon, when one of the news agencies reported conflicting information between the Ministry of Information and the Ministry of Health, causing widespread public anger, particularly due to the closure of facilities based on inaccurate data provided by one of the parties, such inadequacy of the health data really put people and environment in risks (48).

### **An inaccurate determination of geographical location:**

It was clear that the inaccuracy in determining the site for "Ma3an" was the delivery, especially for individuals returning from abroad. It used to apply to people returning from Lebanon, and the phone number is attached to it to monitor this returnee returning to quarantine, but the technical failure was severe. Where not to engage in the application, escape it, or provoke public problems and the Internet for a variety of reasons. This is in addition to the logic of the notion, which was rejected by many individuals and health professionals (51).

### **Lack of cooperation between the ministries:**

Based on the information released by the Ministry of Health, the scope of the conflict that emerged between the ministries was clear, particularly the information that resulted in the complete closure of the country's basic institutions and facilities, such as the airport, seaports, and many vital departments in Lebanon, and this resulted in numerous coordination issues and systematic wariness.

The most crucial statistics published by the Ministry of Health is the disagreement between the Ministries of Health and Economy, Transport, Interior, Foreign Affairs, and Security. For example, the Ministry of Interior has been accused of not being serious about closing facilities via the Ministry of Health, which has aided in the spread of the disease as a result of not taking seriously the information and warnings provided by the Ministry of Health, which relies primarily on digital health data from the operating room. This is in addition to the Ministry of Health's public criticism of the security forces for their harsh tactics in dealing with people, as if there was a military challenge as opposed to a health challenge (52).

### **The data are not interlinked:**

Information conflict is dangerous, particularly if it occurs through the basic digital health platforms of the ministries, due to the weakness of the software systems and technical protocols in the software used. This is exactly what happened repeatedly in Lebanon, in which 173 positive cases of Covid were announced through the operating room and to the media.

Afterwards, the Ministry returned, apologized, and stated that the number of instances is 16, not 173, and reported that there was an error in the announcement of the information, and that the cause was inaccurate communication between the Ministry and the dispersed health centers on the territory of Lebanon.

These failures suggest either a technical flaw, an administrative flaw in the administration of digital health platforms, or a flaw in the manner in which these health centers interface with the Ministry and its technical techniques (53 and 54).

## **5.2 Reflection on the Data Services Framework**

The use of this framework approach, in my opinion, is very important in accurately analyzing the digital health data through its standards. Moreover, the most notable contribution of this framework is its comprehensiveness of digital health data analysis, in terms of managing the entire digital process, in terms of data collection, analysis, evaluation, methods of presentation and storage, and this is what examines the process from start to end, going beyond the ability to simply display and organize data.

It is also distinguished by its capacity to organize technical and encrypted health terminology and to identify approaches and processes that take into account the privacy principle, which is seen as crucial in the digital health plans of key ministries and organizations. It also provided data regarding deaths caused by a particular security or natural threat. The principle of assessing coordinates, which was discovered in this framework, was substantially comparable across all platforms and applications that were examined. This paradigm emphasized the precision of locating patients or emergency health care professionals, as well as health centers and hospitals, rather than any big health event. This section of the framework was functional and aided in the analysis of data retrieved from different platforms and apps.

From my perspective, framework approach lacks the ability to analyze the digital plan itself in terms of the administrative and logistical side of the data, in terms of the level of the team that manages these platforms and extracts the data, or the cost of these reports, or the identification of some of the literature and policies that should have been included in the process of extracting this information to the media.

### **5.3 Study Advantages and Limitations**

As for the benefit of this study, it is its specificity and novelty, as no one in Lebanon, according to my research, has ever conducted a similar study. This makes it a novel research effort in the world of digital health and its information in Lebanon. It is the first study to use literary measurement in managing and analyzing data, drawing conclusions, and presenting recommendations for decision-makers. The information was gathered exclusively from the institutions and a few colleagues, although it was difficult to obtain further information from some other private institutions. Nonetheless, the most effective and well-known platforms in Lebanon were covered, which is one of this study's strengths.

Current study can be considered a shy attempt in the world of digital health and to understand what is happening in Lebanon, to deal with this matter, analyze it, and issue suggestions. It is limited in the framework of analyzing digital health information in Lebanon during the Covid period, which made it a distinguished piece of research. I hope that its readers will benefit from it and it provide will them with a real scientific addition.

## Chapter 6: Conclusions and Recommendations

### 6.1 Conclusions

At the culmination of this study and after assessing the shared digital health data for public in Lebanon, which clearly needs to be improved and worked on many levels, the study concludes:

Through this literature review, we were able to assess the situation of digital health data in Lebanon during the Covid-19 period. Initially, we gathered this data from the sources that made it available to the public. Then, we utilized an usual and effective framework to analyze these digital health data in order to figure out whether the data supplied in Lebanon complies with the requirements established by the World Health Organization using the framework specified for the study. This is what we've sought to compare in order to understand and extract findings.

In terms of the completeness of the information that should be released, the study revealed that the information published in Lebanon is deficient, particularly the information produced by the Lebanese Operations Room of the Ministry of Health. To receive the vaccine, use a second application, the "Together"Ma3an" application, which is also supported by the Ministry of Health, and a third application, the COVAX application. Due to this issue, information was sent to individuals despite the fact that a major portion of them had no knowledge of these programs or their use, which prevented them from answering in full, and the information was also incomplete.

This is in addition to the disorder and inconsistency of information between ministries, which I mentioned in the discussion and which led to numerous errors at the level of strategic decisions in the country, which may have harmed the economy, the health of the people, and the education of children. It also became evident that the geographical identification in the "Ma3an" application was ineffective, just as the platform management was unable to control the locations of those registered in it to follow them up, and this is what caused a great failure, and negligence on the part of citizens, in addition to the technical errors that occurred, especially in The issue of obtaining permissions from the state to move during the general closure, this data was contradictory, insufficient, and mostly useless, and neither residents nor security forces took it seriously.

In addition to the severe economic situation, obstacles such as the continual loss of electricity, water, and the Internet have greatly reduced the effectiveness of health facilities and hospitals in rural areas. As a result, he always believed that the numbers were much higher than what was being circulated by the state or by digital health platforms, due to the fact that rural villages in Lebanon did not share their numbers accurately, given their lack of logistical capabilities, infrastructure, and communications.

In digital health, the human aspect and its development through specialization and development are key. Inadequate human resources specializing in digital health have contributed to the misinterpretation of this situation and the delay in responding in a timely manner, in addition to the inadequacy of managing the digital process at the public level or the level of private institutions, such as preparing private locations to store and protect information and designing the appropriate software for this purpose.

Weak finance has been identified as a serious issue. Today, the majority of digital platforms have been suspended and their projects have been terminated; only the "Ma" platform and the COVAX platform continue to operate, due to a lack of funding, particularly during the country's severe economic crisis and the massive collapse of the Lebanese currency over the past two years. In addition to the ramifications of the Beirut explosion, which drained the majority of money from digital health programs, which are regarded by some as tertiary, the Beirut explosion had a significant impact on funding.

In this regard, I believe that the management of digital health data in Lebanon is crucial. If it is well-managed in terms of planning, organizing, directing, and effective control, digital health projects can be elevated from their current lack to a much higher level in the future. In addition, building policies that drive information management laws must provide a specific portion to digital health policies so that the sector can be developed. Development must begin with the sector's governing policies, its people resources, and the acquisition of the necessary funding. Then we will be able to obtain a more complete produce in the area of digital health data, whose mismanagement can have direct effects on people's health, as seen by the instances we showed after analyzing partial data or insufficient.

At the end of this study and after assessing the shared digital health data for public in Lebanon, which clearly needs to be improved through research and specific projects and program and be supported on many levels.

## 6.2 Recommendations

Recommendations to health decision-makers that will contribute in establishing a digital health policy in Lebanon:

- ✓ Establishing a digital health policy in Lebanon, the last thing that existed in Lebanon was a primitive e-health policy, and this matter can contribute to raising the level of digital health services on the one hand, and raising the level of usefulness of health information analysis on the other, which in turn contributes to raising the level of future health services.
- ✓ Collect health data digitally and circumvent paper documents.
- ✓ Specialized solutions in nearby regions, utilizing batteries or solar energy to power technologies, systems, the internet, and other technical infrastructure.
- ✓ Seeking to provide the internet facility in rural regions through the establishment of regulations for distributing communication networks, which is a significant indication of Lebanon's digital health.
- ✓ Training workers in the field of digital health to manage the digital process in the institutions where they work, regardless of whether they work in the public or private sector.
- ✓ Dealing with companies specialized in the field of digital protection of systems, which contributes to the protection of health information in the regions and the development of a stable digital system.

- ✓ Linking the data gathered from various health centers to achieve optimal results.
- ✓ Connecting health institutions through programmed systems owned by the Ministry of Public Health that contribute to the growth of the health information network, hence enhancing the effectiveness of health services in Lebanon.
- ✓ Raising the quality of scientific research that relies on the analysis of digital health information in particular, and implementing programs to support this research by creating software projects that contribute to the improvement of digital information analysis in Lebanon.
- ✓ Raising the level of information in these platforms, which could contribute to raising the level of benefit, for example when we find additional information about hospital sites, and we see in it the state of water, reaching these hospitals or health centers, or electricity, especially in areas where the electricity is cut off as a result of wars or economic difficulties, as is the case in Lebanon, or adding an information field that determines the level of racial discrimination.
- ✓ We also advocate increasing the level of medical analysis and uploading it to the platforms, since certain medical health findings, such as the percentage of individuals who have recovered from the condition or the infectious complications of the sickness, must be made available to the public. If we have a detailed and mapped account of its spread, we can contribute to the development of more effective treatments in the future.
- ✓ Increasing the level of precision of the attached maps through changes that the state can make using map organizers like Google.
- ✓ Developing laws aimed at increasing the level of respect for the privacy of health information and not neglecting the responsibility for disseminating inaccurate public health information, which contributes to creating real problems in society and institutions and sometimes spreading social panic, particularly if it is related to a health pandemic such as the one we experienced, such as the Coronavirus or the Beirut chemical explosion.
- ✓ Unify efforts targeted at unifying platforms aimed at distributing health information and link them exclusively to the Ministry of Health, particularly with regard to the number of infected individuals, procedures, notifications, and anything new pertaining to the dissemination of health information.
- ✓ By defining cooperation protocols between the Ministries of Health and Information and Communications, it is possible to increase the level of communication between the Ministry of Health and the Ministry of Information, which in turn contributes to coordination and reduces the likelihood of errors or conflicting information, particularly in the event of a health emergency.
- ✓ Conducting initiatives to educate personnel of the Ministry of the Interior and allied security forces on how to respond to people in the event of health emergencies and pandemics. For the success of health plans, dealing with intelligence is crucial. As for the use of force against citizens, it will contribute to widespread rebellion and the failure of health policies. Initially, it contributes to the protection and promotion of health in Lebanon.

- ✓ Inviting investment in the digital health industry by hosting conferences and encouraging efforts that contribute to increasing the digital health market share in Lebanon, hence fostering the growth of the digital health sector in Lebanon. Consideration is given to investing specifically in mobile applications for maintaining health information, evaluating it, and generating suitable reports. A significant national asset upon which significant investments can be built.



## References

- (1) What is Digital Health? FDA [Internet]. 2020. Available on: <https://www.fda.gov/medical-devices/digital-health-center-excellence/what-digital-health>.
- (2) World Health Organization (WHO), Digital Health, Key objectives [Internet]. 2022. Available on: [https://www.who.int/health-topics/digital-health#tab=tab\\_2](https://www.who.int/health-topics/digital-health#tab=tab_2).
- (3) World Health Organization (WHO), Director General's Opening remarks at the Moving Digital Policy into Action event [Internet]. 2022. Available on: <https://www.who.int/director-general/speeches/detail/director-general-s-opening-remarks-at-the-moving-digital-policy-into-action-event>.
- (4) World Health Organization (WHO), Classification of Digital Health Interventions v1.0 [Internet]. 2022. Available on: <https://apps.who.int/iris/handle/10665/260480>.
- (5) Nickerson JW, Hatcher-Roberts J, Adams O, Attaran A, Tugwell P. Assessments of health services availability in humanitarian emergencies: a review of assessments in Haiti and Sudan using a health systems approach. *Conflict and health*. 2015 Dec;9(1):1-1.
- (6) Davenhall WF, Kinabrew C. GIS in health and human services. In *Springer handbook of geographic information 2011* (pp. 557-578). Springer, Berlin, Heidelberg.
- (7) Davenhall WF, Kinabrew C. Geographic Information Systems in Health and Human Services. In *Springer Handbook of Geographic Information 2022* (pp. 781-805). Springer, Cham.
- (8) mWater [Internet]. 2022. Available on: <https://www.mwater.co/about>.
- (9) World Health Organization (WHO), HeRAMS team [Internet]. 2022. Available on: <https://www.who.int/initiatives/herams>.
- (10) World Health Organization (WHO), Health Emergencies [Internet]. 2022 Available on: <https://www.who.int/our-work/health-emergencies>.
- (11) World Health Organization (WHO), Coronavirus disease (Covid-19) pandemic [Internet]. 2022. Available on: [https://www.who.int/emergencies/diseases/novel-coronavirus-2019?adgroupsurvey={adgroupsurvey}&gclid=Cj0KCCQjw0JiXBhCFARIsAOSAKqDffjTV7KozH4DmRTZ4SQtWn0P7dSHWEB6oOYmT BpYFwdILER3N6oaAuaoEALw\\_wcB](https://www.who.int/emergencies/diseases/novel-coronavirus-2019?adgroupsurvey={adgroupsurvey}&gclid=Cj0KCCQjw0JiXBhCFARIsAOSAKqDffjTV7KozH4DmRTZ4SQtWn0P7dSHWEB6oOYmT BpYFwdILER3N6oaAuaoEALw_wcB).
- (12) Jabbour M, El-Jardali F. Harnessing the Power of Digital Health in Responding to Covid-19 and Beyond, American University of Beirut (AUB), Knowledge to Policy (K2P) [Internet]. 2020. Available on: [https://www.aub.edu.lb/k2p/Documents/K2P\\_Harnessing%20the%20Power%20of%20Digital%20Health%20in%20Responding%20to%20COVID-19%20and%20Beyond%20\(reduced\).pdf](https://www.aub.edu.lb/k2p/Documents/K2P_Harnessing%20the%20Power%20of%20Digital%20Health%20in%20Responding%20to%20COVID-19%20and%20Beyond%20(reduced).pdf).

- (13) Rahma for Special Needs, How did RSN Lebanon team cope with the Covid19 crisis [Internet]. 2021. Available on: <http://www.rahmaforspecialneeds.org/>.
- (14) Alanzi T. A review of Mobile Applications Available in the App and Google Play Stores used during the Covid-19 Outbreak [Internet]. 2020. Available on: <https://www.dovepress.com/a-review-of-mobile-applications-available-in-the-app-and-google-play-s-peer-reviewed-fulltext-article-JMDH>.
- (15) Jacoby Carter, Special Report: Digital Healthcare Innovation during Covid-19 [Internet]. 2022. Available on: <https://news.vmware.com/healthcare/digital-healthcare-pandemic>.
- (16) World Health Organization (WHO), HeRAMS Monitoring Covid-19 Response Capacities, [Internet]. Available on: [https://cdn.who.int/media/docs/default-source/documents/emergencies/herams/herams-covid-19-concept-note-en.pdf?sfvrsn=3a7f5cef\\_3&download=true](https://cdn.who.int/media/docs/default-source/documents/emergencies/herams/herams-covid-19-concept-note-en.pdf?sfvrsn=3a7f5cef_3&download=true).
- (17) Nassar, R. The Lebanese healthcare system: where does it stand in the midst of all current crises? [Internet]. 2021. available on: <https://www.linkedin.com/pulse/lebanese-healthcare-system-where-does-stand-midst-all-rita-nassar/>.
- (18) World Health Organization, Lebanon: Health Systems Profile [Internet]. 2018. Available on: <https://rho.emro.who.int/sites/default/files/Profiles-briefs-files/LEB-Health-System-Profiles-2018.pdf>.
- (19) Organigram, Ministry of Public Health and social affairs in Lebanon, general directorate, [Internet]. 2012. available on: [Visio-Current Organizational\(EngAr\).vdx](Visio-Current%20Organizational(EngAr).vdx) (moph.gov.lb).
- (20) Saleh S, Khodor R, Alameddine M, Baroud M. Readiness of healthcare providers for eHealth: the case from primary healthcare centers in Lebanon. BMC Health Services Research. 2016 Dec;16(1):1-1.
- (21) Jermanous M. Chaos in Corona examinations and confusion in laboratory results [Internet]. 2022. Available on: <https://program.almanar.com.lb/episode/201302>.
- (22) Jammal R. Corona chaos in the Lebanese Roumieh prison... an outbreak of the virus and prisoners escalate [Internet]. 2020. Available on: <https://www.alaraby.co.uk/society/%D9%81%D9%88%D8%B6%D9%89-%D9%83%D9%88%D8%B1%D9%88%D9%86%D8%A7-%D9%81%D9%8A-%D8%B3%D8%AC%D9%86-%D8%B1%D9%88%D9%85%D9%8A%D8%A9-%D8%A7%D9%84%D9%84%D8%A8%D9%86%D8%A7%D9%86%D9%8A-%D8%AA%D9%81%D8%B4-%D9%84%D9%84%D9%81%D9%8A%D8%B1%D9%88%D8%B3-%D9%88%D8%A7%D9%84%D8%B3%D8%AC%D9%86%D8%A7%D8%A1-%D9%8A%D8%B5%D8%B9%D9%91%D8%AF%D9%88%D9%86>.

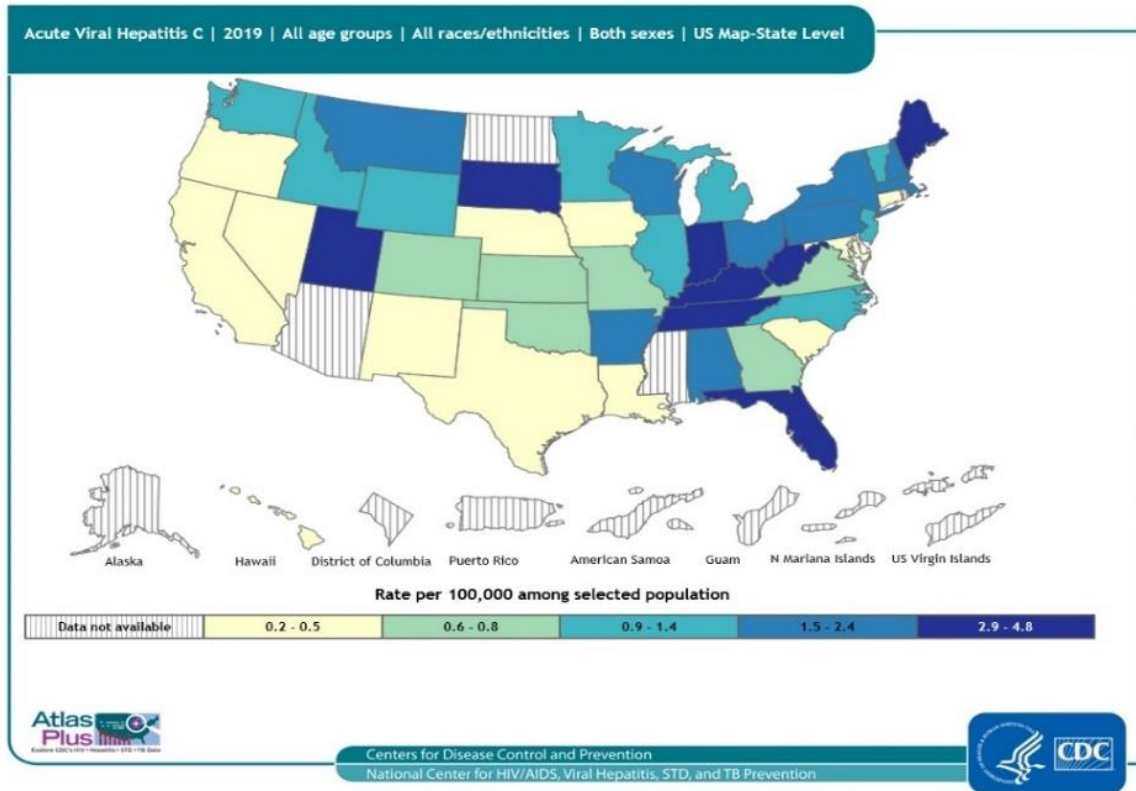
- (23) Awad N. MTV announces state of emergency, criticizes government for politicizing Coronavirus [Internet]. 2020. Available: <https://arab.news/4gsvk>.
- (24) Abdallah M. "Representatives First"... Tweeters expose the vaccination chaos in Lebanon [Internet]. 2021. Available on: <https://roayahnews.com/articles/2021/02/23/665242/%D8%A8%D8%B9%D8%AF-%D8%A3%D8%B2%D9%85%D8%A9-%D8%A7%D9%84%D8%A8%D8%B1%D9%84%D9%85%D8%A7%D9%86-%D9%81%D9%88%D8%B6%D9%89-%D9%84%D9%82%D8%A7%D8%AD%D8%A7%D8%AA-%D9%83%D9%88%D8%B1%D9%88%D9%86%D8%A7-%D9%85/>.
- (25) Schaefer E, Werner N, Scanlon M. Information chaos in the electronic health record as a threat to patient safety. International Conference on Human-Computer Interaction 2021 Jul 24 (pp. 189-196). Springer, Cham.
- (26) Saleh MA, Manjunath KR. Fighting COVID-19 in Yemen: The role of Public Administration and Readiness of Healthcare system. Mukht Shabd Journal. 2020;9(6):1459-72.
- (27) Jabbour M, El-Jardali F. Harnessing the Power of Digital Health in Responding to COVID-19 and Beyond, Knowledge to Policy (K2P) Center, Beirut, Lebanon [Internet]. 2020. Available on: [https://www.aub.edu.lb/k2p/Documents/K2P\\_Harnessing%20the%20Power%20of%20Digital%20Health%20in%20Responding%20to%20COVID-19%20and%20Beyond%20\(reduced\).pdf](https://www.aub.edu.lb/k2p/Documents/K2P_Harnessing%20the%20Power%20of%20Digital%20Health%20in%20Responding%20to%20COVID-19%20and%20Beyond%20(reduced).pdf).
- (28) Republic of Lebanon, Ministry of Information [Internet]. 2022. Available on: <http://www.ministryinfo.gov.lb/en/>.
- (29) World Health Organization, The Data Services Framework(4.0), Classification of Digital Health Interventions [Internet]. 2018. Available on: <https://www.who.int/publications/i/item/WHO-RHR-18.06>.
- (30) Koweyes J, Salloum T, Haidar S, Merhi G, Tokajian S. Covid-19 pandemic in Lebanon: One year later, what have we learnt?. Msystems. 2021 Apr 20;6(2):e00351-21.
- (31) Live COVID-19 Vaccination Tracker, Lebanon [Internet]. 2022. Available on: <https://covidvax.live/location/lbn>.
- (32) Telecom Review, New milestone towards e-health in Lebanon [Internet]. 2018. Available on: <https://www.telecomreview.com/index.php/articles/exclusive-interviews/2229-new-milestone-towards-e-health-in-lebanon>.

- (33) Ministry of Public Health in Lebanon, The national E-Health Program, Introduction [Internet]. 2022. Available on: <https://moph.gov.lb/en/Pages/6/2651/national-e-health-program>.
- (34) Ministry of Public Health in Lebanon, The national E-Health Program, E-Health Initiative [Internet]. 2022. Available on: <https://www.moph.gov.lb/userfiles/files/Programs%26Projects/NationalE-healthProgram/E-Health%20Solutions-2014.pdf>.
- (35) Talhouk R, Mesmar S, Thieme A, Balaam M, Olivier P, Akik C, Ghattas H. Syrian refugees and digital health in Lebanon: Opportunities for improving antenatal health. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems 2016 May 7 (pp. 331-342).
- (36) Cuijpers P, Heim E, Abi Ramia J, Burchert S, Carswell K, Cornelisz I, Knaevelsrud C, Noun P, van Klaveren C, van't Hof E, Zoghbi E. Effects of a WHO-guided digital health intervention for depression in Syrian refugees in Lebanon: A randomized controlled trial. PLoS medicine. 2022 Jun 23;19(6):e1004025.
- (37) Statista, Digital Health, Lebanon [Internet]. 2022. Available on: <https://www.statista.com/outlook/dmo/digital-health/lebanon>.
- (38) Lebanon National Operations Room, Daily Report on COVID-19 [Internet]. 2020. Available on: <https://docslib.org/doc/10233377/lebanon-national-operations-room-daily-report-on-covid-19>.
- (39) World Health Organization, Global, Lebanon [Internet]. 2020. Available on: <https://covid19.who.int/region/emro/country/lb>.
- (40) Beirut Port Explosion and COVID19 pandemic [Internet]. 2022. Available on: <https://www.redcross.org.lb/>.
- (41) American University of Beirut Medical Center (AUBMC) Coronavirus Disease (COVID-19) [Internet]. 2020. Available on: <https://aubmc.org.lb/COVID-19/Pages/covid-19.html>.
- (42) Lebanese American University Medical Center-Risk Hospital [Internet]. 2022. Available on: <https://www.laumcrh.com/covid-19>.
- (43) Hôtel Dieu de France, University Medical Center. [Internet]. 2022. Available on: <https://www.hdf.usj.edu.lb/en/visits>.
- (44) Rafik Hariri University Hospital [Internet]. 2015. Available on: Available on: <http://www.bguh.gov.lb/>.
- (45) "Ma3an" Together Against Corona, Republic of Lebanon, Ministry of Public Health [Internet]. 2022. Available on: <https://www.moph.gov.lb/en/ma3an>.

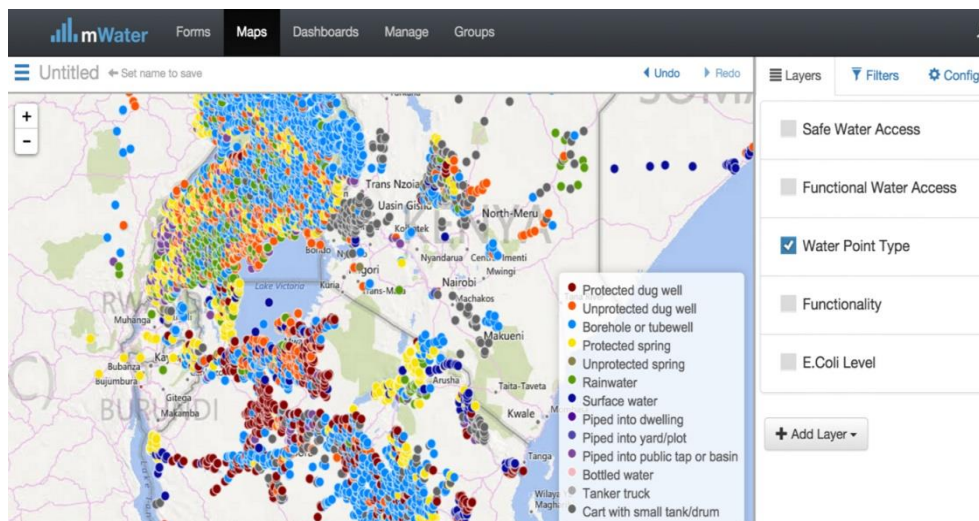
- (46) What is Interoperability in healthcare? [Internet]. 2022. Available on: <https://www.ibm.com/topics/interoperability-in-healthcare>.
- (47) Increase in the corona threat [Internet]. 2020. Available on: <https://anbaaonline.com/news/67501>.
- (48) Conflict in Corona statistics in Lebanon [Internet]. 2020. Available on: [https://arabic.rt.com/middle\\_east/1132656-%D8%AA%D8%B6%D8%A7%D8%B1%D8%A8-%D9%81%D9%8A-%D8%A5%D8%AD%D8%B5%D8%A7%D8%A6%D9%8A%D8%A9-%D9%83%D9%88%D8%B1%D9%88%D9%86%D8%A7-%D9%81%D9%8A-%D9%84%D8%A8%D9%86%D8%A7%D9%86/#](https://arabic.rt.com/middle_east/1132656-%D8%AA%D8%B6%D8%A7%D8%B1%D8%A8-%D9%81%D9%8A-%D8%A5%D8%AD%D8%B5%D8%A7%D8%A6%D9%8A%D8%A9-%D9%83%D9%88%D8%B1%D9%88%D9%86%D8%A7-%D9%81%D9%8A-%D9%84%D8%A8%D9%86%D8%A7%D9%86/#).
- (49) ICT works, 3 Key Challenges to Data Cleaning in Digital Development programs [Internet]. 2022. Available on: <https://www.ictworks.org/data-cleaning-digital-development/#.Y5I9I3ZBzrc>.
- (50) COVID-19 updates available on Almanar [Internet]. 2020. Available on: <https://program.almanar.com.lb/episode/201302>.
- (51) Lebanon imposes home quarantine on arrivals instead of hotel quarantine [Internet]. 2021. Available on: <https://asharq.com/ar/4era2Hxqa7qEdSYiISLK1m-%D9%84%D8%A8%D9%86%D8%A7%D9%86-%D9%8A%D9%81%D8%B1%D8%B6-%D8%A7%D9%84%D8%AD%D8%AC%D8%B1-%D8%A7%D9%84%D9%85%D9%86%D8%B2%D9%84%D9%8A-%D8%B9%D9%84%D9%89-%D8%A7%D9%84%D9%88%D8%A7%D9%81%D8%AF%D9%8A%D9%86/>.
- (52) Lebanon: Corona dominance through conflicting government measures [Internet]. 2020. Available on: <https://thepublicsource.org/ar/too-little-too-late-timeline-lebanons-response-covid-19>.
- (53) Conflict in Corona statistics in Lebanon [Internet]. 2022. Available on: [https://www.janoubekhbria.com/2020/07/blog-post\\_994.html](https://www.janoubekhbria.com/2020/07/blog-post_994.html).
- (54) Bou-Hamad I, Hoteit R, Harajli D. Health worries, life satisfaction, and social well-being concerns during the COVID-19 pandemic: insights from Lebanon. PLoS One. 2021 Jul 29;16(7):e0254989.
- (55) Centers for Disease Control and Prevention, Maps, Acute Viral Hepatitis C 2019 of USA, All age groups [Internet]. 2020. Available on: <https://gis.cdc.gov/grasp/nchhstpatlas/maps.html>.

# Annexes

## 1. Example on the GIS Acute Viral Hepatitis C visual map of USA- 2019 (55)



## 2. The mWater technology for water and health (8)

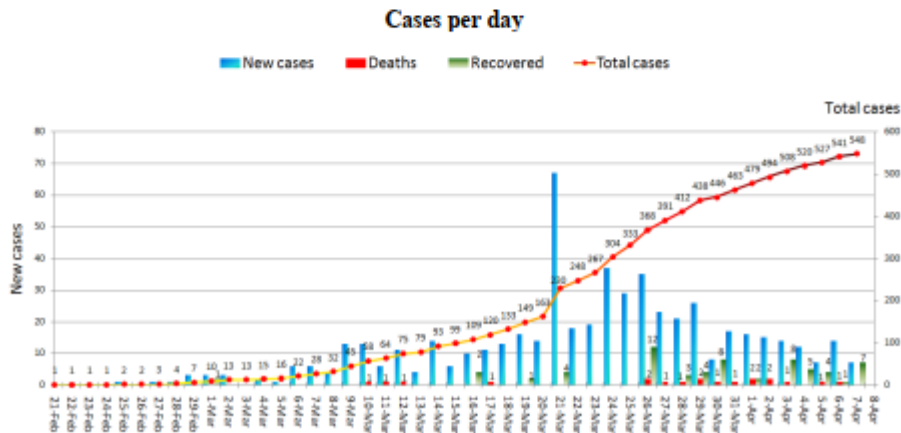
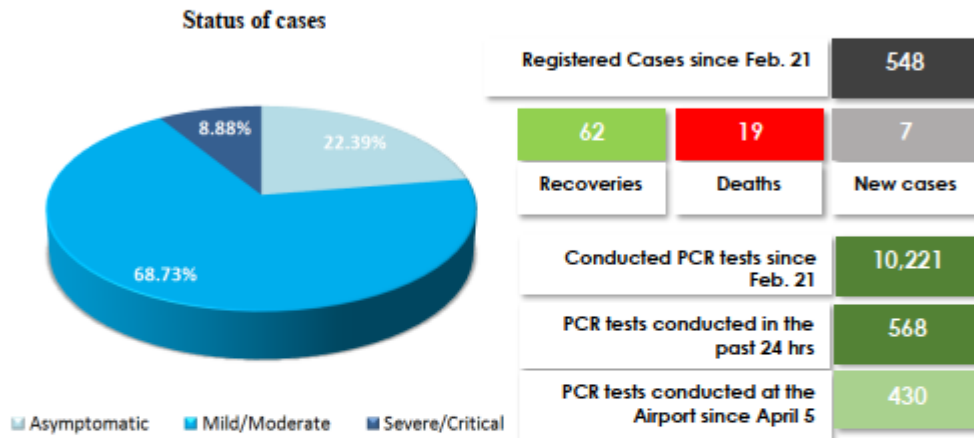


### 3. Lebanon National Operation Room Dashboard

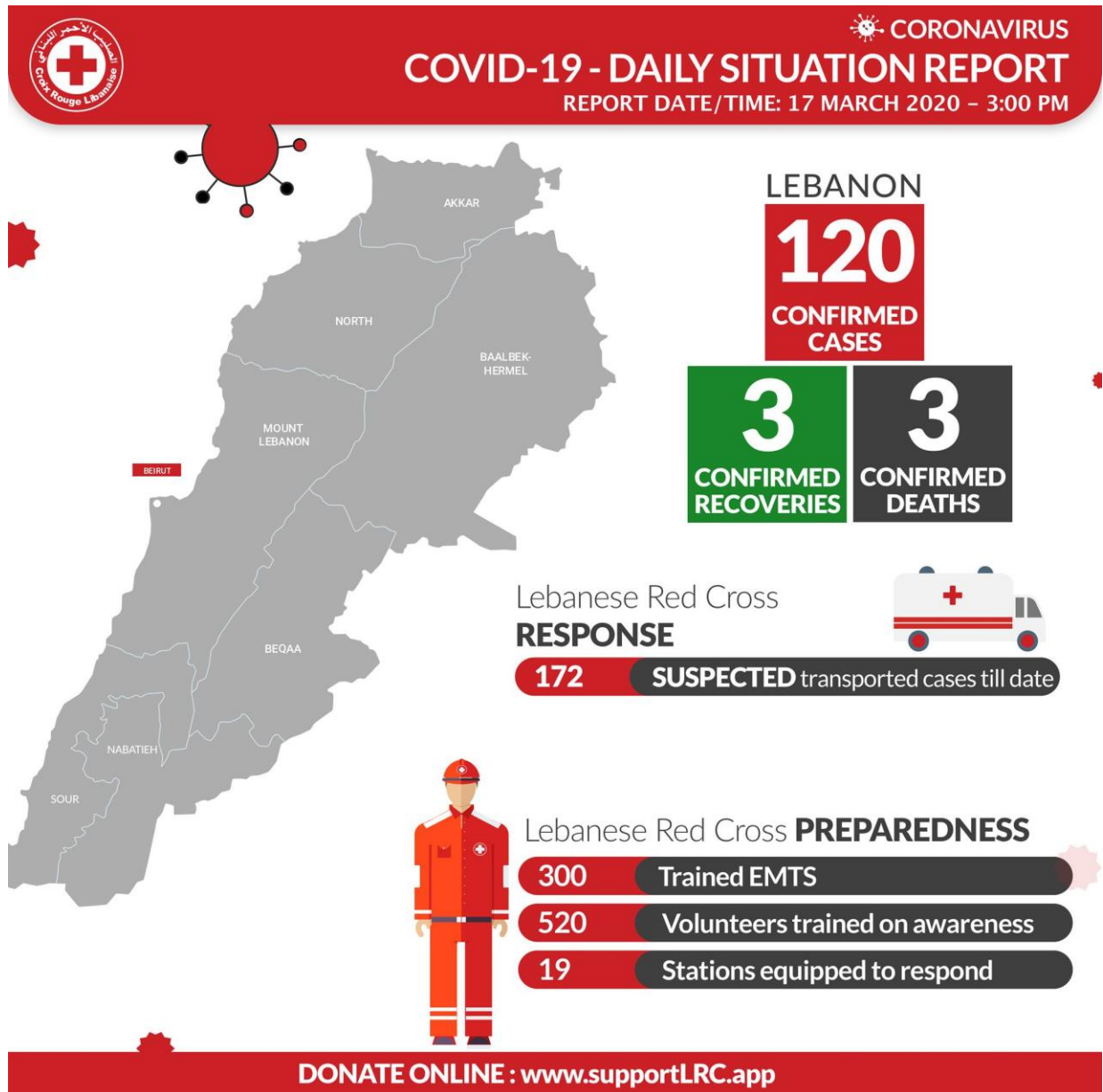


## Lebanon National Operations Room Daily Report on COVID-19 April 7, 2020

Tuesday, April 7, 2020
Report #20
Time Published: 17:00

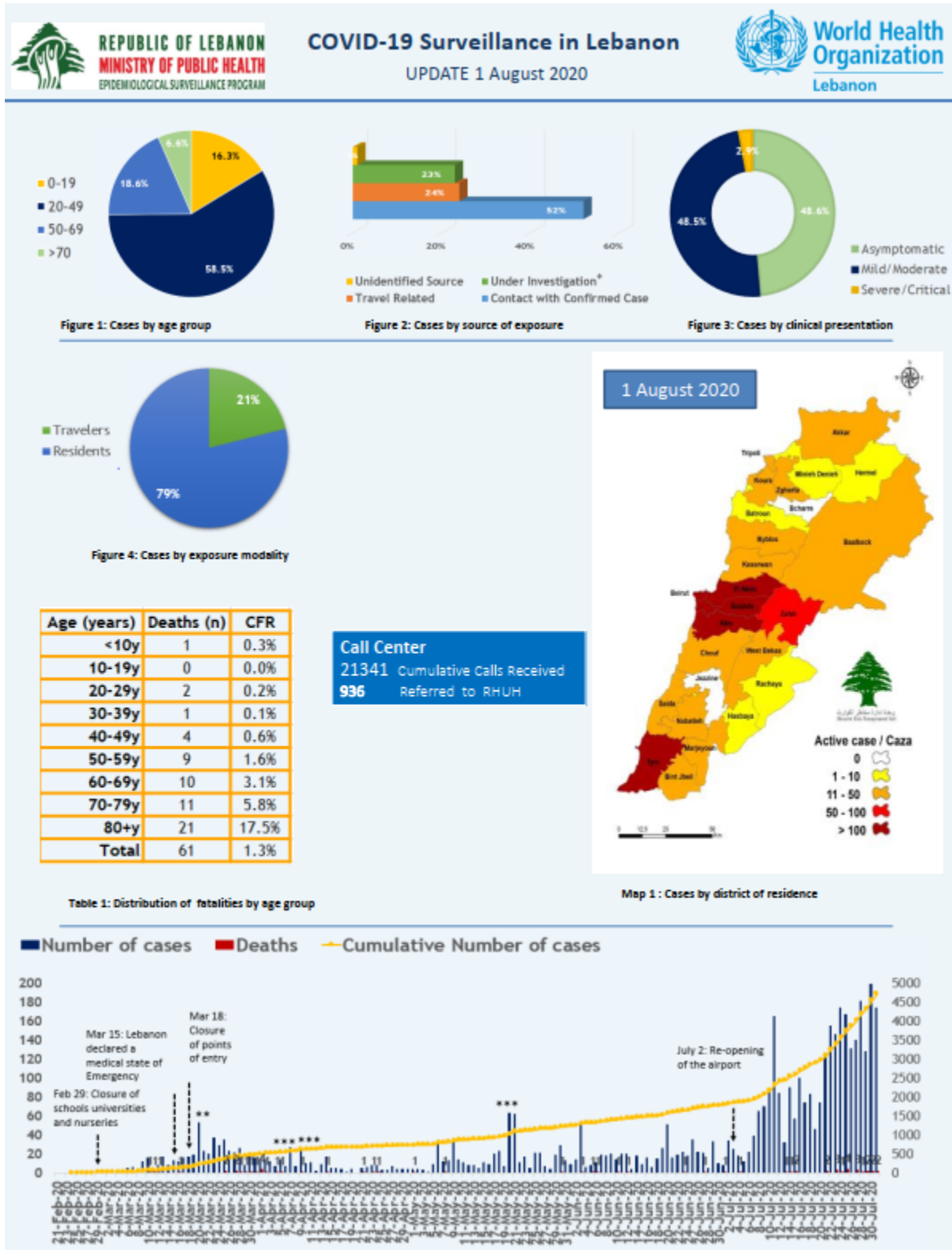


#### 4. Lebanese Red Cross Dashboard

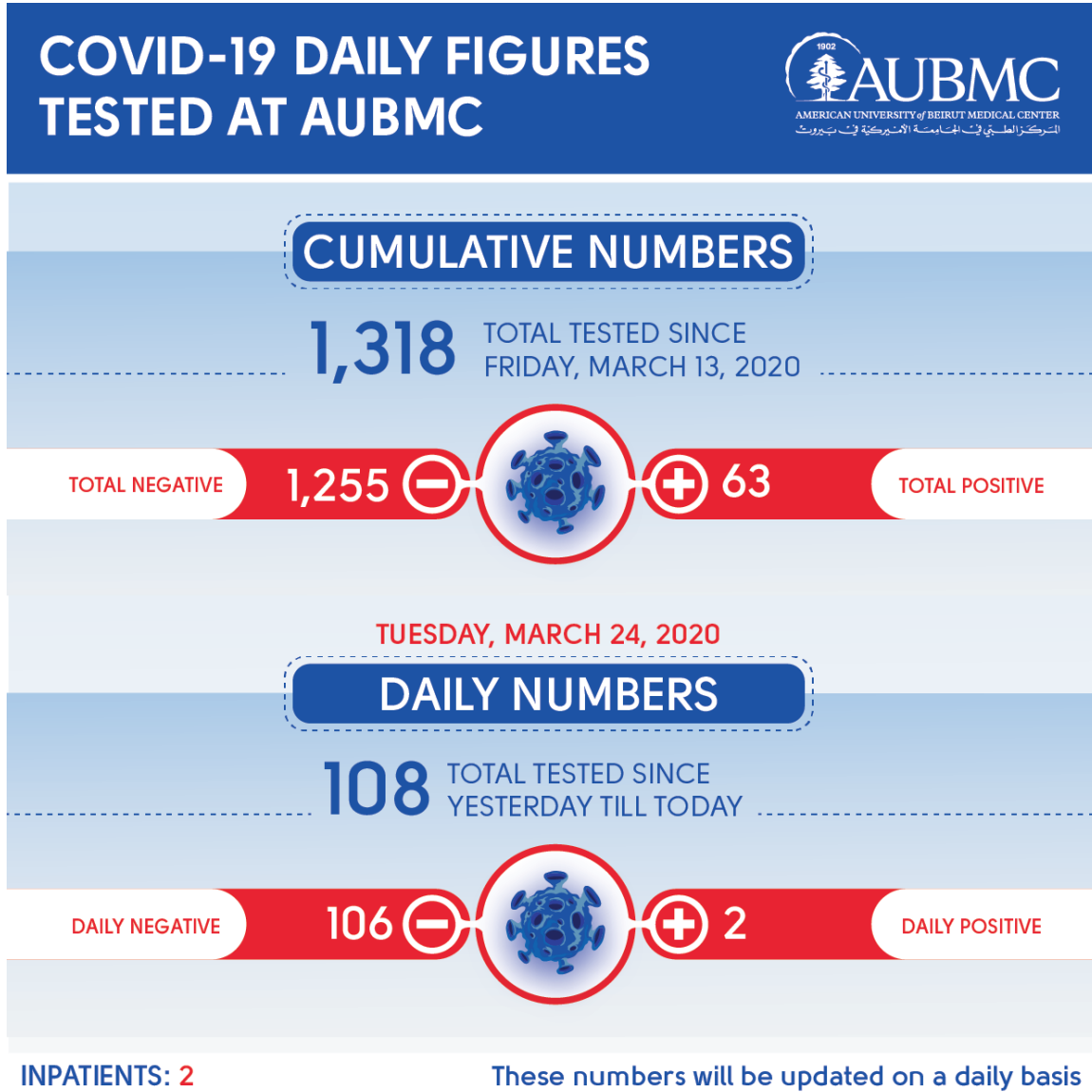




## 5. WHO Lebanon COVID-19 Surveillance in Lebanon



## 6. American University of Beirut Medical Center Daily Dashboard

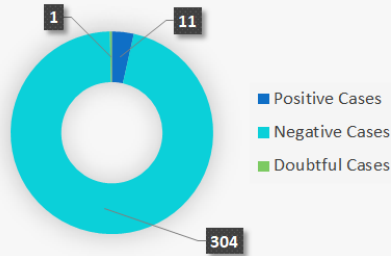


## 7. Lebanese American University Medical Center Daily Dashboard

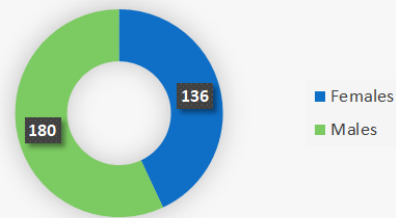
**COVID-19 Suspected Cases**  
 Division of Clinical Microbiology  
 Report up to 26 March 2020

Total Tested Cases  
**316**

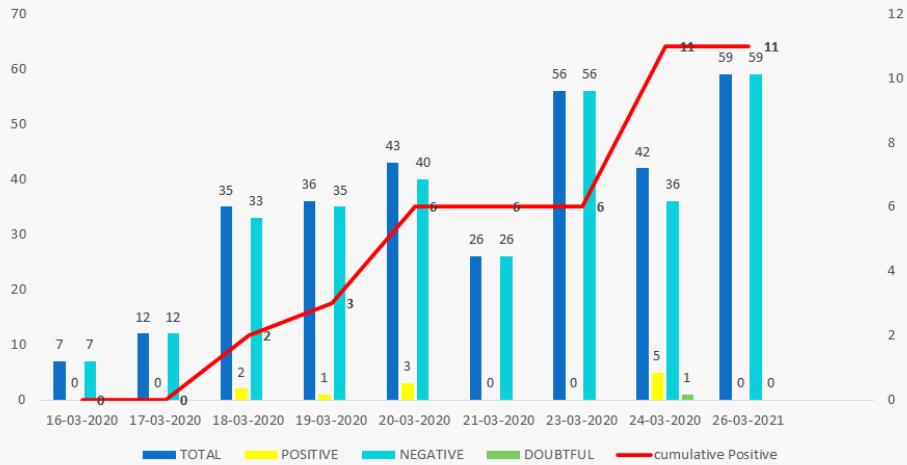
**Positive Vs Negative Cases**



**Tested Patients Segmented By Gender**



**Number of Patients Tested for COVID-19**



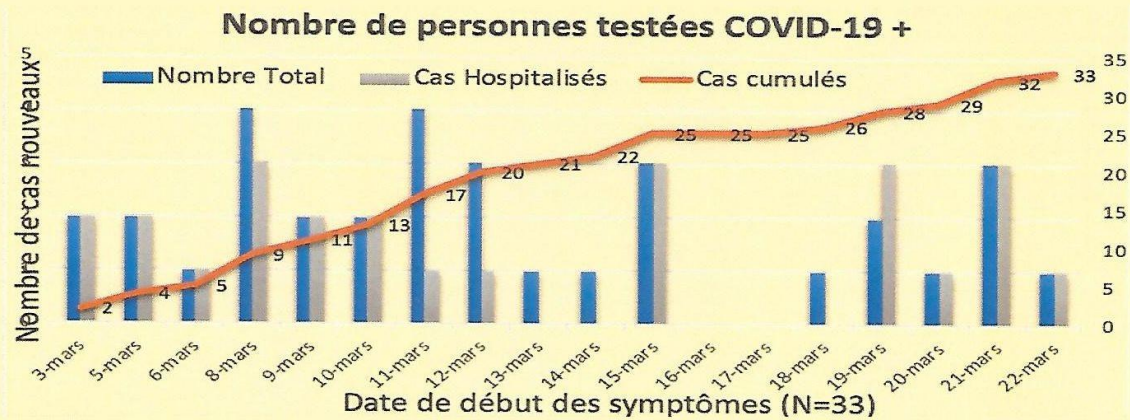
Note: All COVID-19 positive cases are communicated on a daily basis to the Lebanese Ministry of Health

## 8. Hotel-Dieu de France Hospital Daily Dashboard




HOTEL-DIEU DE FRANCE  
Centre Hospitalier de l'Université Saint-Joseph de Beyrouth

### Bulletin Journalier Unité de Surveillance COVID-19 Rapport du 23 mars 2020



## 9. Covax platform by Impact



الرجاء تقديم سؤالك هنا Search here

التسجيل لأخذ اللقاح  
Register to take vaccine

قيم تجربتك في المستشفى  
Evaluate your experience at the hospital

إعادة إرسال الرابط عن طريق الرسائل القصيرة  
Resend Link by SMS

**IMPACT - Open Data**  
موقع البيانات المفتوحة IMPACT هو مبادرة من التفقيش المركزي لإتاحة الوصول إلى البيانات التي تم جمعها رقميًا. هذه الآلية هي الأشمل اليوم على صعيد الدولة والتي يتم إجراؤها بالتعاون مع مختلف الوزارات والبلديات.

[الذهاب إلى الموقع](#)

استمارة التسجيل لأخذ اللقاح المضاد لفيروس كورونا (كوفيد-19)  
Covid-19 Vaccine pre-registration form

الجمهورية اللبنانية  
وزارة الصحة العامة



## 9. Ma3an Mobile Application:

2:53 4G 30%

1787  
www.ma3an.gov.ly

وزارة الصحة العامة



مرفعة إضافية "جافي" أنتت على فعالية خطة وزارة الصحة لنشر اللقاعات

مراكز توزيع الأدوية Drugs Dispensing Centers		لائحة اسعار الأدوية Drugs Price List	
شكاوى Complaints		آخر الفيديوهات Video Channel	
حدّد موقع أقرب مستشفى Locate Nearest Hospital		آخر الأخبار Latest News	

## Research Strategy:

Country/Region	Topics	Others
<b>Lebanon</b>	Digital Health Technology AND/OR Health Disaster	Health Information Systems (HIS)
<b>Lebanon</b>	Digital Health Technology AND/OR COVID-19	Digital Platforms, Websites, Applications
<b>Lebanon</b>	Digital Health Policy	Ministry of Public Health
<b>Lebanon</b>	Digital Health Challenges	UNHCR, IRC, Unicef, OCHA, NRC
<b>Lebanon</b>	Information Chaos AND/OR Covid-19	Infected People
<b>Lebanon</b>	Digital Health AND/OR Patient Safety	Refugees/ Vulnerable
<b>Lebanon</b>	National Agenda AND/OR Digital Health	Platforms Chaos
<b>Lebanon</b>	HeRAMS, mWater	Lessons Learned from the power of one platform
<b>Tanzania</b>	Health Facilities System	Lessons Learned from the power of one platform
<b>Worldwide</b>	WHO Digital health classification framework	Analysis tool
<b>Worldwide</b>	Data Security	Security programing in Health institutions
<b>Worldwide</b>	Digital Health Data Analyzing	Analyzing Strategies
<b>Worldwide</b>	Data Cleaning, Dirty Data	Analyzing tools