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Are there more resilient countries in managing health crises? Insights from the Covid-19 pandemic

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Master in Health Services Management

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Resumo

A pandemia de COVID-19 redefiniu a gestão de crises em saúde, o que originou diferenças significativas na resiliência dos países. Esta dissertação analisa os fatores que influenciam a resiliência no combate à pandemia, avaliando três indicadores principais: Taxa de Incidência, Mortalidade e Vacinação. Cada uma foi comparada analiticamente com os pilares do *Global Health Security Index*. O estudo revelou diferenças significativas entre as regiões geográficas, o que demonstra como os grupos globais variam na sua resiliência. Os resultados indicam que fatores culturais, como maior distância ao poder e coletivismo, estão associados a uma maior resiliência. Por outro lado, países com tendência para evitar a incerteza, orientação a longo prazo e indulgência apresentaram maiores taxas de incidência e mortalidade, mas melhores resultados na vacinação. Além disso, a resiliência foi influenciada pela capacidade de deteção e reporte na mortalidade, conformidade com normas internacionais na incidência, e ambiente de risco na vacinação. Estas conclusões sublinham a importância de adaptar estratégias de resposta a crises às características culturais e contextuais de cada país, evitando a aplicação de soluções uniformes em diferentes ambientes. O estudo fornece insights cruciais para o desenvolvimento de planos estratégicos que considerem tanto fatores objetivos quanto subjetivos, como a capacidade de adaptação a novos contextos. Assim, realça-se a importância de uma abordagem flexível e contextualizada na gestão de crises de saúde, de forma a garantir uma resposta eficaz e ajustada às necessidades específicas de cada país.

Palavras-chave: Gestão de Crise; COVID-19; Resiliência; Saúde Pública Global; GHSI; Cultura

Classificação JEL: I18 - Política Governamental; Regulamentação; Saúde Pública; H12 – Gestão de Crise

Abstract

The management of unexpected health crises has evolved significantly with the recent COVID-19 pandemic, which has affected the world in various ways and to different degrees. This pandemic marks a turning point in how health crises are approached. This dissertation aims to identify the key factors that explain the resilience of countries in combating the COVID-19 pandemic. Resilience was accessed at three levels: the Incidence Rate, the Mortality Rate and the Vaccination Rate of COVID-19. Each of these aspects was compared, using regression analysis with the six pillars of the Global Health Security Index. The study found significant differences between the six official WHO regions, showing how global groups vary in their resilience. The analysis showed that cultural factors and GHSI scores help explain these differences. The most resilient countries combating the pandemic were those of higher distance to power and more collectivist while those with tendency to avoid uncertainty, long-term orientated and indulgent presented worse outcomes in terms of Incidence and Mortality but showed better Vaccination Rates. Furthermore, the resilience in combating the COVID-19 disease is explained by Detection and Reporting in case of Mortality, Compliance with International Norms for the Incidence and Risk Environment for Vaccination Rate of the disease. The study emphasizes the need for adaptable, context-specific strategies to manage crises, acknowledging that uniform approaches often fail. While cooperation and established norms are vital, each country must tailor its response to its unique cultural, social, and economic factors for effective crisis management.

Keywords: Crisis Management; COVID-19; Resilience; Global Public Health; GHSI; Culture

JEL Classification: I180 - Government Policy; Regulation; Public Health; H12 - Crisis Management

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List of Acronyms

CN	Commitments to Improving National Capacity, Financing and Adherence to Norms
DR	Detection and Report
GHSI	Global Health Security Index
GDP	Gross Domestic Product
HS	Health System
ICU	Intensive Care Units
IDV	Individualism versus Collectivism
IHR	International Health Regulations
IVR	Indulgence versus Restraint
LTO	Lont Term versus Short Term Orientation
MAS	Masculinity versus Femininity
PDI	Power Distance
PE	Prevention of Emergency
RE	Risk Environment
RR	Rapid Response
SARS	Severe Acute Respiratory Syndrome
UA	Uncertainty Avoidance
UN	United Nations
WHO	World Health Organization

1. Introduction

1.1. Contextualization and Problem Discussion

In 2019, an outbreak of pneumonia emerged in Wuhan, China, associated with a new strain of coronavirus that was named by the World Health Organization (WHO) as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-Cov-2) (Fernandes et al., 2022). From the outset, the emergence of SARS-CoV-2 raised serious concerns within the scientific community due to the potential threat it represented to the global public health (Sharma et al., 2021). Indeed, the outbreak rapidly evolved into a global pandemic with significant impact across various domains (Donelli et al., 2022), not only in health but also in environmental, economic, educational, and human psychology (Miyah et al., 2022).

This event has reinforced the importance of effective management of unexpected public health crises, namely, as infectious diseases. Whether on a smaller or on a larger scale, such crises always demand strategies and planning in order to mitigate their negative impact. The sphere of impact caused by crises such as respiratory tract infections is of immense significance, as their consequences encompass short, medium, and long-term mortality and morbidity (Choi et al., 2020).

Throughout history, humanity has been exposed to various health crises and the effort to deal with them played a crucial role in learning and providing useful insights to mitigate similar crises. There was constant development and improved preparedness to deal with these events, as public health emergencies are inevitable and can arise anywhere and at any time (Khorram-Manesh & Burkle, 2020). However, there is still a long way to go. Failures and errors in the recent pandemic have existed, however, it would be more pedagogical to understand which areas in the crisis management were most vulnerable. By doing this, improvements will come and the same mistakes in a future crisis can be avoided. The avoidance of these mistakes is crucial to protect population and systems from all around the globe (Destoumieux-Garzón et al., 2022).

In 2019, the Global Health Security Index (GHSI) was introduced as a pioneering tool to evaluate and rank countries based on their preparedness for public health crises, assessing various dimensions of health security. This comprehensive index aims to provide a clear picture of each country's readiness to manage health emergencies.

By 2022, the GHSI was updated with more detailed and refined data, offering an even deeper analysis of each nation's capabilities. This updated version also includes specific recommendations for governments on enhancing their preparedness for future health crises. The index serves not only as a benchmarking tool but also as a guide for policymakers to improve their health security measures.

Despite the GHSI’s detailed framework and its intentions to standardize health security assessments, several critical questions remain. Firstly, does the GHSI accurately predict a country’s ability to manage a health crisis effectively? This question raises important concerns about the reliability of the GHSI's predictions and recommendations. Are there other crucial factors influencing a country's success in handling public health emergencies that the GHSI might overlook? For instance, cultural, social, and political contexts vary significantly across countries and can profoundly impact crisis management (Mustafa, et al 2021).

Moreover, the GHSI's standardized approach prompts a critical examination of whether a "one-size-fits-all" index is the most adequate for all the participating countries. Can a single set of criteria adequately account for the diverse and complex realities faced by different nations? It is essential to explore whether the GHSI can be adapted or supplemented with additional indicators to more accurately reflect each country's unique circumstances and capabilities (Mahajan, 2021).

In light of these considerations, this thesis seeks to evaluate the GHSI's effectiveness in predicting countries' preparedness and resilience in face of public health crises, using insights from the most recent COVID-19 pandemic. Additionally, it aims to identify other factors, particularly cultural dimensions, that may play a significant role in determining a country's ability to manage health emergencies. By doing so, this research hopes to contribute to a more nuanced and comprehensive understanding of global health security and to suggest improvements for future iterations of the GHSI.

1.2. Purpose

The relevance and primary purpose of this study lies in the evaluation of the reliability of the GHSI and its capacity to predict countries' preparedness and resilience to face health crises, specifically by the use of data retrieved from COVID-19 outcomes. This research aims to uncover whether the GHSI can accurately predict the effectiveness of a country's response to a public health emergency and to identify additional factors, like cultural dimensions, that may significantly influence a country's resilience.

This analysis will focus on the six pillars of the GHSI—Prevention of Emergence (PE), Detection and Reporting (DR), Rapid Response (RR), Health System robustness (HS), Compliance with International Norms (CN), and Risk Environment (RE). By scrutinizing these pillars, the study seeks to determine whether any specific component has a superior predictive profile regarding a country's ability to manage and mitigate the impact of the COVID-19 crisis.

To achieve the study's purpose, several objectives have been established, grounded in the central research questions: “Which categories of the GHSI best explain resilience in combating COVID-19?”, “What are the main differences in the GHSI between geographical groups?” and “What types of culture showed more resilience in combating COVID-19?”. The overarching objective is to identify the factors that most significantly influence the success of a country's crisis response, using the COVID-19 pandemic as a case study to provide practical insights and real-world data.

In addition to the assessment of the GHSI's predictive power, this study will explore the role of cultural dimensions in shaping a country’s health crisis response. Therefore, this study establishes as specific objectives to determine the predictive power of the GHSI pillars in the COVID-19 outcomes in terms of Incidence, Mortality and Vaccination rates; to identify which global regions demonstrated greater resilience in combating the COVID-19 crisis and to analyse the differences among the regions; and to explore cultural tendencies that contribute to the resilience in the fight against COVID-19.

The relevance and innovation of this dissertation stem from its potential to identify strategic intervention points based on its findings and conclusions. These insights could be integrated into strategic planning processes to enhance the robustness and resilience of health crisis management in the future. By providing a more nuanced understanding of the factors that contribute to successful health crisis responses, this research aims to inform and improve global health security strategies, ultimately leading to more effective preparedness and response mechanisms for future pandemics and health emergencies.

During the research, no ethical implications are foreseen since all the information collected and processed comes from public sources available on the internet and the study is not at the individual level.

2. Literature Review

2.1. Health Crisis Contextualization

Health is a dynamic field susceptible to variations and factors that can negatively affect it. Thus, health crises are recurrent and assume different intensities. Crises in this context can therefore take on endemic, outbreak, epidemic, or pandemic dimensions (Riley, 2019).

The terms endemic, outbreak, epidemic, and pandemic indicate how common a condition is at a point in time relative to how common it was at an earlier time and are often used to categorize infections. These categories are primarily based on how many cases of a condition are detected compared with the expected number of cases over a given time and how far the cases have spread geographically (Grennan, 2019).

An endemic condition occurs at a steady, predictable rate within a specific population, with the number of cases being roughly what is expected. This population can range from the residents of a town or country to larger areas like countries or continents. Examples include malaria in Africa, valley fever in the southwestern United States and northern Mexico, dengue in tropical and subtropical regions, and hepatitis B worldwide, with higher rates in Asia and Africa compared to Europe and North America (Grennan, 2019).

An outbreak is when a sudden increase of a number of people with a condition is greater than expected. The condition may either have more cases than anticipated for an endemic disease, or it may appear in a location where it has not been previously found. Outbreaks are usually in small areas. Examples include cholera after the 2010 Haiti earthquake, E. coli from contaminated food, Ebola in Africa since 1976, and measles in unvaccinated children at a US theme park in 2015 (Grennan, 2019).

An epidemic is an outbreak that spreads over a larger area. Examples include the Zika virus starting in Brazil in 2014 and spreading to most of Latin America and the Caribbean, the 2014-2016 Ebola outbreak in West Africa, and the US opioid crisis (Grennan, 2019).

A pandemic is an epidemic that spreads globally. The 1918 Spanish flu which infected over one-third of the world and killed around 50 million people is an example (Aassve et al., 2021). Other influenza pandemics occurred in 1957, 1968, and with H1N1 in 2009 and more recently, COVID-19 (Grennan, 2019).

Pandemics of influenza, cholera, and plagues are part of global history. Outbreaks, whether at the level of regional epidemics or as worldwide pandemics of infectious diseases continue to cause significant morbidity and mortality around the world and remain unpredictable in nature not respecting borders or political structures (Gully, 2020).

In the last century, the world faced four pandemics: the Spanish flu pandemic of 1918-1919, the SARS (Severe Acute Respiratory Syndrome) pandemic of 2003, the H1N1 pandemic (or swine flu) of

2012, and the COVID-19 pandemic. Each of these public health crises has exposed different problems, providing crucial lessons for better managing future health emergencies (Pergolizzi et al., 2020). These and other examples throughout history have impacted the way health crises are perceived today and have supported the implementation of diverse response measures. Conclusions of studies that have focused on crisis management in this context and the way it has been addressed, converge on the point of view that there has been a continuous improvement in management strategies over the years (Krammer et al, 2018) and that in most countries, preparation programs for future pandemics have been established after outbreaks but there is still wide room for improvement (Short et al, 2018). The importance of flexible approaches is often emphasized once it allows countries to develop and implement their own strategies based on WHO guidelines (Rudenko et al, 2015). The capacity for adaptation becomes even more important considering the new challenges faced in the 21st century (Short et al, 2018).

The global outbreak of SARS that began in late 2002 in China gained worldwide attention in March 2003. Characterized by easy transmission and by causing severe illness, it revealed difficulties of developed countries to deal with the widespread of the disease through recognition and response. This led to the acceptance by WHO Member States of the International Health Regulations (IHR) as a way to improve global management of infectious diseases outbreaks and other public health events (Gully, 2020). The IHR were put into action six years later due to the swine flu pandemic, which assisted in outbreak response plans by providing reports for countries. National focal points were identified for communication with WHO, integrating information received from State Parties and non-governmental sources to deliver temporary recommendations concerning the management of the pandemic and monitor responses for unnecessary trade, travel and human rights restrictions. Yet challenges were observed in terms of vaccine supply and delivery as by then the regulations were not fully operational (Wilson et al., 2010). From this perspective, it was concluded that there was still global fragility regarding preparedness to respond to a severe flu pandemic or any other global public health crises (World Health Organization, 2011).

Currently, health crisis management has gained more importance due to the recent pandemic that brought the world to a standstill, the COVID-19. The crisis began in the city of Wuhan, China, and triggered an outbreak of SARS-CoV-2 from late 2019 onwards, which quickly spread globally, attaining the pandemic status on March 11th, 2020 (World Health Organization, 2020). Therefore, countries implemented various measures aimed at reducing the spread, and there was an employment of strategic plans and standards developed previously in the aftermath of past public health crises, refining them to ensure the necessary updates considering the modern context and the current challenges (Mayo et al., 2021).

During the crisis, vaccination efforts aimed at achieving herd immunity and the "incremental improvement of proactive measures" (Sharmin et al., 2021) represent crucial factors for the successful management of public health crises worldwide. However, vaccination goals were so far not achieved largely due to modern obstacles to vaccine acceptance, including hesitancy, diminished altruistic intentions, distrust in science and government agencies. These barriers have negatively impacted immunization rates globally, resulting in epidemics and pandemics of severe and potentially fatal infections caused by vaccine-preventable diseases. Additionally, pathogens once considered controlled or eradicated are resurging with new genetic characteristics, which makes them more capable of evading natural and acquired immunity, including that induced by currently available vaccines (Stevens & Bryant, 2023).

2.1.1. Health Crisis Management

2.1.1.1. Crisis Management

Crisis management is a process that encompasses preparation for controlling and limiting damage from unexpected negative events. This practice involves the anticipation of threats and the development of strategies to minimize harm as well as implementing these strategies when a crisis occurs.

Regardless of the organization's size or type, crises share certain attributes. These attributes represent a threat to a system, involve an element of surprise, require actions to change the course of events, and demand fast decision-making. Emergencies can occur suddenly when an event happens that is beyond control or can develop over time as a small problem worsens because the system does not see or fails to act on warning signs (Bundy et al., 2017).

Effective crisis management is a structured process essential for organizations and systems facing unforeseen threats that jeopardize their operations and reputation. These crises follow a well-defined cycle with distinct stages: from the early detection of warning signs to the resolution and learning phases. Various models, such as Fink's four-stage approach (Fink, 1968) and Mitroff's five-stage framework (Mitroff, 1994), provide systematic guidelines for crisis management, emphasizing stages like signal detection, damage containment, and recovery. Coombs' three-stage model (Coombs, 2012) underscores the importance of proactive measures during the pre-crisis phase, crisis recognition and containment during the event, and strategic post-crisis actions to rebuild trust and prevent recurrence. The implementation of these strategies involves robust planning, agile response mechanisms, and transparent communication to mitigate impact and foster resilience. In the context of health crises, effective crisis management not only addresses immediate challenges but also shapes public perception and prepares systems for future uncertainties, emphasizing the dynamic nature of crisis communication and the strategic evolution of response strategies over time (Pan & Meng, 2016).

Effective crisis management leads some countries to success when combating the infections from the coronavirus. One successful example is Vietnam with approximately 100 million habitants. On December 31, 2020, one year and 44 days after the first confirmed COVID-19 case was detected, Vietnam reported 1465 infections and 35 deaths. As a comparison, Portugal with approximately 10 million habitants, on December 27, 2020, had had 377 474 confirmed COVID-19 cases and a total of 6685 deaths.

Vietnam's success was attributed to several key factors: a well-developed public health system, a decisive central government and a proactive containment strategy that involved comprehensive testing, tracing, and quarantining. The country had prior experience with health crises, including the SARS epidemic in 2003 and human cases of avian influenza between 2004 and 2010, which provided valuable insights and infrastructure for taking appropriate actions. Vietnam's government made many key containment decisions within days, whereas other countries took weeks or even months to act. Despite being highly centralized, Vietnam also empowered local authorities to make critical decisions, which contributed to the swift and effective response (Our World in Data, 2020).

To minimize disruptions in health services and the resulting excess mortality and morbidity during health emergencies, countries must incorporate context-specific considerations into their ongoing and future emergency planning. This involves embedding strategies for quality maintenance, routine, and essential health services within emergency preparedness and response plans. Special attention should be given to local epidemiology through the identification of gaps and vulnerabilities in health systems capacity and assessment of the severity of disruptions caused by crises. This assessment should be based on past and ongoing public health emergencies, including relevant evaluations and reviews (Mustafa, 2022).

2.1.1.2. Burden originated from the COVID-19 pandemic

The impact of the pandemic caused by COVID-19 was felt across all sectors. The health systems and infrastructure were not the only ones affected by the pandemic and what came along with it. Social distancing measures, quarantine rules, and strict travel restrictions have significantly reduced the workforce and caused widespread job losses across all industrial sectors.

Education was one of the sectors significantly impacted by COVID-19. Due to lockdown restrictions, schools closed, forcing a rapid shift to online teaching methods, which were not always successful. Issues such as limited access to online platforms and resources for students, along with reduced attention and supervision from parents and teachers, were commonly observed. Literature highlights several negative consequences for children, including increased screen time, unhealthy weight gain, and a rise in the prevalence of overweight and obesity (Chaabane et al., 2021).

Another sector that revealed significant vulnerabilities due to the impact of COVID-19 was the tourism industry. Lockdown measures and travel restrictions led to a sharp decline in tourist arrivals worldwide, that severely affected the gross domestic product (GDP) of many countries, especially those heavily reliant on tourism as a major source of income (Škare et al., 2020).

Small businesses suffered massively due to the pandemic. In the United States of America, 43% of small businesses temporarily closed, with nearly all of these closures attributed to COVID-19. This situation highlighted the financial fragility of many small businesses, which makes them less resilient to environmental instabilities and the variances experienced during the health crisis (Bartik et al., 2020).

The restaurant industry has also been severely affected by the pandemic. Some consequences included business closures, employee layoffs, price increases due to decreased demand, increased bank loans, higher rates of business bankruptcies, financial instability, and reduced dining room capacity as a result of public health measures (Gomes et al., 2022).

While the impact on other sectors has been significant, the health sector understandably faced severe organizational and infrastructural challenges due to COVID-19, which were beyond what could have been imagined.

Emergency facilities worldwide had to stretch their capacities. The COVID-19 pandemic placed unprecedented stress on healthcare systems globally, necessitating treatment capabilities and resources that far exceeded normal emergency surge capacity due to the massive influx of COVID-19 patients and those concerned about the disease (Mareiniss, 2020). Radical efforts to increase treatment space were undertaken, including statewide cancellations of elective surgeries and exhortations for hospitals to double their medical and surgical ward beds. At New York-Presbyterian's Weill Cornell Medical Center, hospital administrators cancelled elective procedures and converted operating rooms and post-anesthesia care units into intensive care units (ICU), resulting in a 50% increase in ICU capacity (Klein et al., 2020). In Europe, hospitals postponed elective treatments to free up beds and added ICU beds equipped with ventilators while maintaining essential services such as urgent consultations, necessary treatments like chemotherapy and dialysis, maternal services, and rehabilitation (Elke et al., 2021).

As a result of this strain on healthcare systems, the availability of medical resources decreased leading to heightened mortality risks for patients with chronic illnesses (French et al., 2022). Additionally, there was an increase in fatalities related to mental depression, suicide, and violence amid the pandemic (Shang et al., 2022). These events represented the Excess Mortality. The WHO defines Excess Mortality as "the mortality above what would be expected based on the non-crisis mortality rate in the population of interest".

The pandemic's impact extends far beyond the direct deaths caused by COVID-19. Overwhelmed health systems and patients avoiding care have led to additional deaths. Conversely, in countries where lockdowns and other measures limited COVID-19 spread, there were decreases in deaths from causes like air pollution, traffic accidents, and other communicable diseases such as influenza, resulting in negative excess or deficit deaths (Kung et al., 2021) (Karlinsky & Kobak, 2021).

Despite the massive negative impact on all sectors including the global economy and health, the pandemic has offered opportunities to learn, improve, and prepare for other future pandemics. Literature indicates that global cooperation failed during the first two years and highlights the need for improvement. Ensuring safety requires the reinforcement of basic pandemic control measures globally: universal vaccine coverage, appropriate physical distancing and face mask use, prudent controls on potential superspreader events, safe workplaces, surveillance for new variants, global protocols for safe international travel, and the scale-up of test-trace-and-isolate regimens to maintain low community transmission (Sachs et al., 2022).

Future health crisis management should include the reassessment and update of the IHR, bolstering WHO's role and funding and strengthening global public health systems. The prevention of natural spillovers requires a One Health approach, integrating human, animal, and ecosystem health. Given that future pandemics will stem from human-animal interactions and ongoing virus research, countries must rigorously monitor the trade of domestic and wild animals and monitor research activities (Sachs et al., 2022).

Governments should increase funding for health systems, with development aid supporting low-income countries to ensure strong public health and primary healthcare systems, to achieve universal health coverage. Investments should also enhance medical supply chains and research and development in behavioural, social, and implementation sciences to ensure effective health interventions. Strengthening health systems must address inequalities in gender, ethnicity, race, income, and accessibility (Garrett Wallace Brown et al., 2023).

For emergency preparedness and maintenance of primary and mental healthcare during crises, national health systems need more investment in surveillance, outbreak response, and communication expertise. Quality health education must be accessible, and funding for major global health concerns like HIV/AIDS, tuberculosis, malaria, immunizations, maternal mortality, and neglected tropical diseases should be increased and made resilient (Belita et al., 2022).

Health workers, including community health workers, must be well-trained, well-paid, and well-supported. Sustainable investments in education and training for health professionals in low- and middle-income countries are crucial for responsive health systems. Engaging communities, civil society, and local groups in health system strengthening will improve pandemic responses and overall health (Ballard et al., 2020).

The key lesson from COVID-19 consisted in the necessity of national preparedness and global cooperation. Comprehensive cross-sectoral pandemic plans supported by global coordination are essential. WHO member states should adopt national pandemic preparedness plans that meet international standards, supported by the Pandemic Treaty and IHR regulations (World Health Organization, 2023).

The recommendations pass for the strengthening of multilateralism across political, cultural, institutional, and financial dimensions. Countries, especially the richest, should support the United Nations (UN) system and promote solidarity, cooperation, and sustainable development (United Nations, 2020).

To effectively handle unexpected health crises and minimize their long-term impacts on both people and the global community, it is crucial to strengthen the capacity of countries. This will increase resilience and reduce the lasting effects, which can be felt for decades.

2.2. Cultural Dimensions

During the height of the pandemic, as the virus spread rapidly and caused global concern, countries exhibited varied reactions and capacities to manage the situation. While a nation's decisions and measures significantly influenced COVID-19 outcomes, other factors such as experience, culture, and social environment also played crucial roles in determining resilience to the crisis (Mahajan, 2021). Therefore, context-specific strategies and evaluations are essential in health crisis management planning. This approach should be informed by the distinct cultural characteristics and differences that have been shown to influence the effectiveness of crisis response. Accordingly, this study aims to do an approach of whether cultural factors contribute to differences in the management of health crises.

According to Geert Hofstede, “Culture is the collective programming of the mind that distinguishes the members of one group or category of people from others” (Hofstede, 2011). Based on this framework, a tool has been developed to evaluate each country's cultural orientation across six dimensions using a scale from 0 to 100. These dimensions include Power Distance (PDI), which explores how societies address inequality; Uncertainty Avoidance (UA), reflecting a society's tolerance for uncertainty; Individualism versus Collectivism (IDV), which assesses the balance between individual and group identity; Masculinity versus Femininity (MAS), examining gender role differentiation; Long Term versus Short Term Orientation (LTO), focusing on future versus past/present orientations; and Indulgence versus Restraint (IVR), indicating attitudes towards gratification of human desires. These dimensions collectively provide insights into societal values and behavioural tendencies that shape responses to challenges such as the COVID-19 pandemic.

2.2.1. Power Distance

Power distance represents the extent to which less powerful members of organizations and institutions accept and expect unequal power distribution. This means that inequality is supported by both followers and leaders in a society. Power and inequality are basic aspects of any society, and while all societies have some level of inequality, the degree of inequality varies from one society to another (Hofstede, 2011).

Authors point out that PDI has a negative relationship with the number of COVID-19 infections. High PDI societies are more likely to accept differences in knowledge and intellectual capabilities while less PDI nations tend to value free will and are more likely to question experts. The reflections of these facts in the public health sphere suggest that societies that are culturally less attuned to follow directions and display obedience may also be less inclined toward social mitigation, thus limiting their ability to curb pathogen transmission and presenting less spread of the disease (Dheer et al., 2021).

2.2.2. Uncertainty Avoidance

Uncertainty Avoidance differs from risk avoidance. It concerns a society's comfort level with ambiguity and reflects how much a culture conditions its members to feel uneasy or at ease in unstructured scenarios. These scenarios are characterized by their novelty, unpredictability, and deviation from the norm. Cultures with high Uncertainty Avoidance strive to reduce the occurrence of such situations through strict behavioural codes, laws, and rules, disapproval of unconventional behaviour, and a firm belief in absolute truth (Hofstede, 2011).

Theory suggests that nations with a higher tendency toward UA tended to experience greater growth in COVID-19 infections. These nations may perceive the “cure to be worse than the disease”. This outcome is also likely due to initial confusion and controversy surrounding the health benefits of mitigation measures during the early stages of COVID-19 (Dheer et al., 2021) (Wang et al., 2022) (Lajunen et al., 2022).

2.2.3. Individualism

Individualism, in contrast to Collectivism, describes how tightly knit individuals are within a society. In individualistic cultures, there is a loose connection between individuals; each person is expected to primarily care for themselves and their immediate family. On the other hand, collectivist cultures integrate individuals into strong, cohesive in-groups from early in life, often extended families that offer protection in exchange for unquestioning loyalty, while also emphasizing opposition to other groups (Hofstede, 2011).

Collectivist cultures are believed to exhibit better disease outcomes during COVID-19 compared to more individualistic cultures. Literature suggests that Collectivism promotes adherence to stringent governmental guidelines on quarantine, social distancing, and hygiene, even when these measures seem overly restrictive or severe by individualistic standards. Conversely, individualistic cultures have been associated with lower adherence to epidemic control measures and therefore, presented a higher incidence of infection cases (Rajkumar, 2021).

2.2.4. Masculinity

Masculinity, in contrast to Femininity, refers to a society's distribution of values between genders, a fundamental issue with varying solutions. Values differ significantly between men and women across societies. In masculine societies, male values are assertive, competitive, and distinct from female values, which tend towards modesty and caring. In feminine societies, both men and women share similar modest and caring values, with men being somewhat assertive and competitive but less so than in masculine societies (Hofstede, 2011).

The literature suggests that societies with a more masculine culture tend to experience higher numbers of confirmed COVID-19 cases and deaths. This association is believed to stem from observations that countries with high masculinity may face greater challenges in complying with public health control measures, leading to increased infections and fatalities (Chen & Biswas, 2022).

2.2.5. Long/Short Term Orientation

Nations exhibit distinct characteristics in terms of the level of their longevity orientation. Long Term Orientation cultures emphasize values such as perseverance, thrift, hierarchy in relationships, and a sense of shame. In contrast, Short Term Orientation cultures prioritize reciprocating social obligations, respect for tradition, maintaining social reputation, and personal stability (Hofstede, 2011).

According to the literature, cultures with a Long-Term Orientation often struggle with the strictness of social distancing measures. This cultural dimension is linked to traditional values, and this negative association suggests that societies with strong long-term orientation may find it challenging to adapt quickly to new circumstances and challenges, such as those posed by COVID-19 (Ashraf et al., 2022) (Ma et al., 2022) (Chen & Biswas, 2022).

2.2.6. Indulgence

Indulgence describes a society where people freely satisfy basic human desires, enjoying life and having fun. Restraint, on the other hand, describes a society that restricts the gratification of needs and regulates behaviour through strict social norms (Hofstede, 2011).

Typically, indulgent societies are more extroverted and prioritize leisure, while restraint societies are governed by strict social norms and often have a fatalistic outlook. Due to these factors, literature suggests that indulgent societies might experience worse COVID-19 disease outcomes (Erman & Medeiros, 2021).

2.3. Conceptual Framework

2.3.1. COVID19 resilience indicators

The widespread dissemination of COVID-19 infection on a global scale has compelled countries to adapt, develop, and implement crisis management strategies to provide a robust and effective response, fully ensuring the stabilization of each country's healthcare system. Each country then adopted its individualized strategy within the norms of higher entities to which they belong, such as the European Union in the case of some European countries and dealt differently with the various challenges posed by the pandemic. As a result, a diversity of strategies was observed among different healthcare systems, leading to different outcomes. Countries that implemented more effective strategies, considering their context and needs, demonstrated greater resilience in combating the crisis, experiencing less negative impact (Trump & Linkov, 2022).

Healthcare systems are based on various functions that need to work together constantly to provide safe and quality health services. These functions are susceptible to shocks and changes. If a healthcare system cannot withstand the pressure of a particular shock, it may cease to function or collapse (Djalante et al., 2020). The concept of resilience was introduced with the aim of strengthening healthcare systems to prevent disruptions or collapses and is new in research in this context, with no common description to explain its meaning. One of the first definitions emerged in 1973 and defines resilience as "the ability to absorb change and disturbances and still maintain the same relationships between populations or state variables" (Holling, 1973). This has been adjusted over time and for various areas, adopting a more dynamic interpretation that incorporates adaptive and transformative capabilities that allow the system to adjust or change its own characteristics or actions to mitigate future crises, maintain its basic structure, or even fundamentally alter its structure to completely eliminate the risk, should its current state become unsustainable (Folke et al., 2010).

A resilient health system is one that can effectively prepare for, respond to, and adapt to disruptive public health events, such as pandemics, while maintaining the continuity of essential, high-quality health services across all levels of the health system (WHO, 2024). Achieving this requires integrating health emergency planning with the broader sector strategy, ensuring appropriate budgets, and monitoring and evaluation frameworks for both anticipated and unexpected interventions. Despite extensive discussions on the necessity of health system resilience (Haldane et al., 2021), fragmentation between health system strengthening, emergency preparedness and response, and disease-specific initiatives continues to impede progress toward key global health objectives such as health security and universal health coverage (Spicer et al., 2020). To date, evidence on the degree of integration and incorporation of a resilience perspective within planning has been limited in discussions surrounding COVID-19 and broader health systems (Lal et al., 2020).

One of the main learnings inherent in the COVID-19 pandemic is that crisis management is a complex process that requires individual, organizational, and institutional responses in a large-scale coordination involving interdisciplinary and multidisciplinary approaches. Resilience emerges as a key factor for success in reducing the negative impact of this crisis in different sectors, with an emphasis on health. When a country demonstrates resilience in responding to and combating the crisis, it potentially becomes less susceptible to increasing infection and death rates caused by the disease (Haldane et al., 2021).

Today, it is recognized that crises in the healthcare sector are inevitable. The history of combating public health crises highlights the importance of ensuring the effective functioning of the system to minimize the negative impact of events as much as possible. When considering the most recent crisis of the last century, the one caused by COVID-19, it becomes evident that there was not an effective crisis management, resulting in the collapse of various entities affecting health on a global level and also impacting sectors such as the economy, society, education, and supply chains (Saulnier et al., 2023). It is therefore crucial to dig into the various approaches of countries while facing the crisis, for example, by identifying the factors that can contribute most to resilience in its combat. This enables the reduction of incidence rates, mortality, among others. Thus, it becomes imperative to develop strategic plans based on various factors that are explanatory of the resilience demonstrated by each healthcare system and each country's plans.

As part of the main goal of the present dissertation several dependent variables represented by the outcomes from the COVID-19 pandemic of each country's crisis management efficiency were approached. In this study, the data considered to correspond to the countries' resilience were the Incidence Rate and the Mortality Rate resultant from COVID-19 infections and the Vaccination Rate.

Each of these three indicators represents a consequence of each step of the Coomb's three-stage model of crises management (Figure 2.1). Accordingly, the Incidence Rate reflects the first stage of the model – the importance of proactive measures during the *pre-crisis phase* – while the Mortality Rate covers the middle step - containment *during the crisis* – and, finally, the Vaccination Rate represents the last moment – strategic *post-crisis* actions to rebuild trust and prevent a recurrence.

Incidence and Mortality rates are two of the frequency measures used to characterize the occurrence of health events in a population. Because these rates put disease frequency in the perspective of the size of the population, they are particularly useful for comparing disease frequency in different locations or among different groups with potentially different-sized populations, which is the case of the countries that have different levels of population (Dicker et al., 2006).

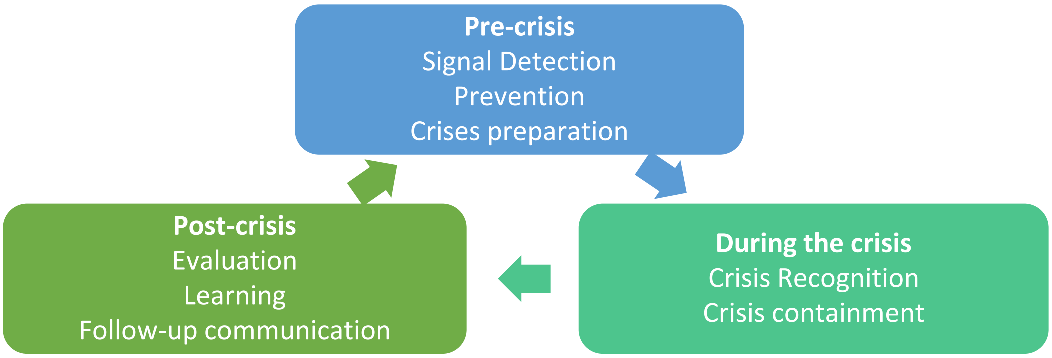


Figure 2.1 – Coomb's three-stage model of crisis management.

The COVID-19 pandemic has underscored the necessity for enhanced preparedness for future viral outbreaks. Since the onset of the pandemic, the global scientific community has significantly advanced its understanding of the complex and evolving dynamics of SARS-CoV-2, which has profoundly influenced the development of COVID-19 vaccines (Ulrichs et al., 2024). The first vaccine outside the clinical trial setting was administered on December 8, 2022. COVID-19 vaccination has substantially altered the course of the pandemic, saving millions of lives globally (Watson et al., 2022).

2.3.1.1. Incidence Rate

Like most RNA viruses, coronaviruses evolve rapidly, with changes occurring over months or years that can often be observed and measured. Most SARS-CoV-2 infections are acute and typically resolved by the immune system within 10–15 days after symptoms begin. Once SARS-CoV-2 infects an individual, viral particles are produced exponentially in the respiratory tract, reaching peak levels around 2–5 days post-infection, which generally coincides with the onset of symptoms. This pattern holds for most SARS-CoV-2 variants, except for Omicron, which peaks around 3 days after symptoms start (Markov et al., 2023).

In the initial stages, before vaccines were developed and preliminary studies were underway, epidemiologists and public health experts concentrated on analysing various factors. They closely monitored incidence rates over time, making comparisons between different groups and areas. Understanding the epidemiological behaviour of the virus was crucial in determining the most effective strategies to combat it.

Given this, the importance of including the Incidence Rate in the context of this dissertation is undeniable. It remains one of the most critical measures for monitoring the disease to this day. The virus spread rapidly worldwide, with some regions being significantly more affected and demonstrating less resilience in containing the crisis and preventing infections (Figure 2.2).

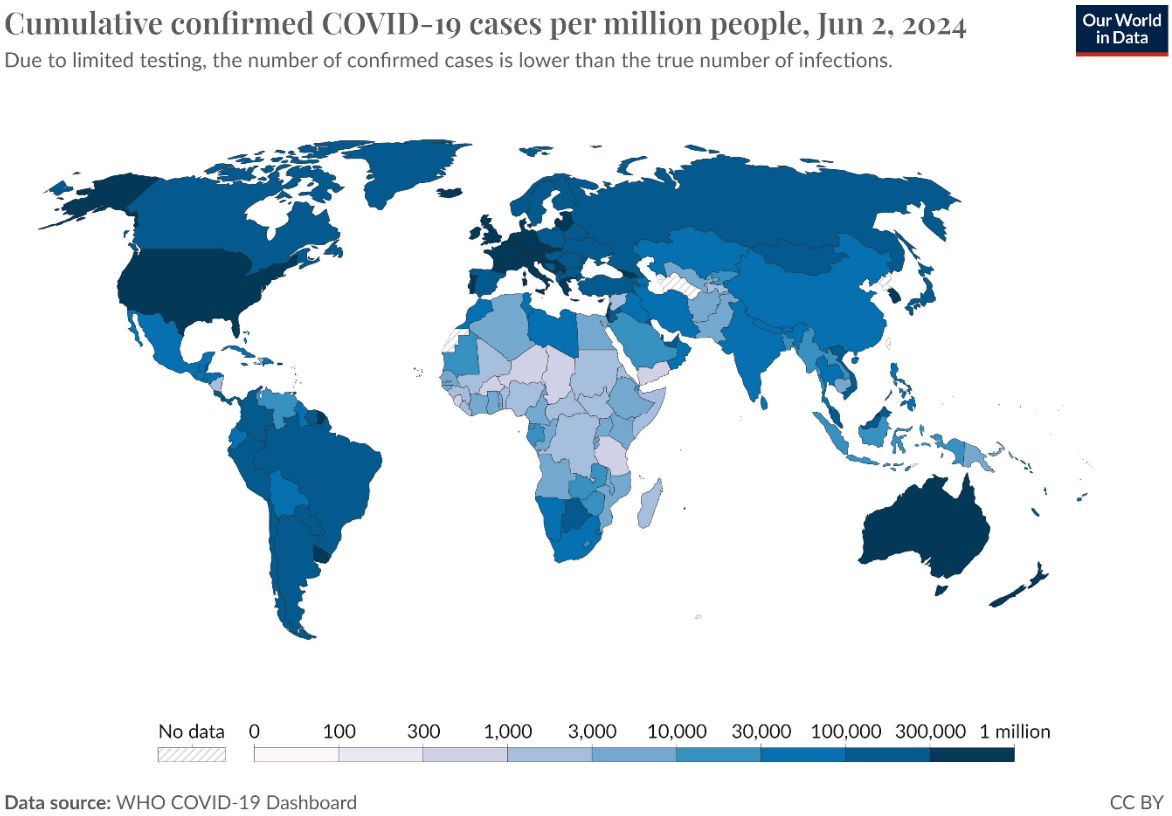


Figure 2.2: Cumulative confirmed COVID-19 cases per million people until June 2nd, 2024, worldwide.

2.3.1.2. Mortality Rate

Unfortunately, the virus caused deaths across the globe, affecting individuals of all ages, genders, nationalities, and social standings. The rapid and intense spread of the virus demonstrated a high level of aggressiveness, and in areas with limited healthcare access, this resulted in the deaths of hundreds of thousands of people worldwide.

Several determinants are believed to impact mortality, such as the age distribution of populations. It has been observed that countries with older populations experience significantly higher mortality rates. Mortality associated with COVID-19 is a multifactorial process, influenced by underlying health conditions, healthcare system capacity, and age. These factors collectively contribute to the higher mortality observed in certain demographics (Bulut & Kato, 2020).

Given this, the importance of the Mortality Rate in the context of this dissertation is undeniable. It remains one of the most critical measures for monitoring the disease to this day. The virus spread rapidly worldwide, taking away the lives of more than 7 million people (Figure 2.3).

The actual number of deaths caused by the COVID-19 pandemic may be approximately three times higher than official reports indicate. According to reports, the true death toll by December 31, 2021, was estimated to be nearly 18 million (Wang et al., 2022). This far exceeds the 5.9 million deaths officially reported for the same period. The discrepancy is attributed to significant undercounts in official statistics, caused by delayed and incomplete reporting, as well as a lack of data from numerous countries (Adam, 2022).

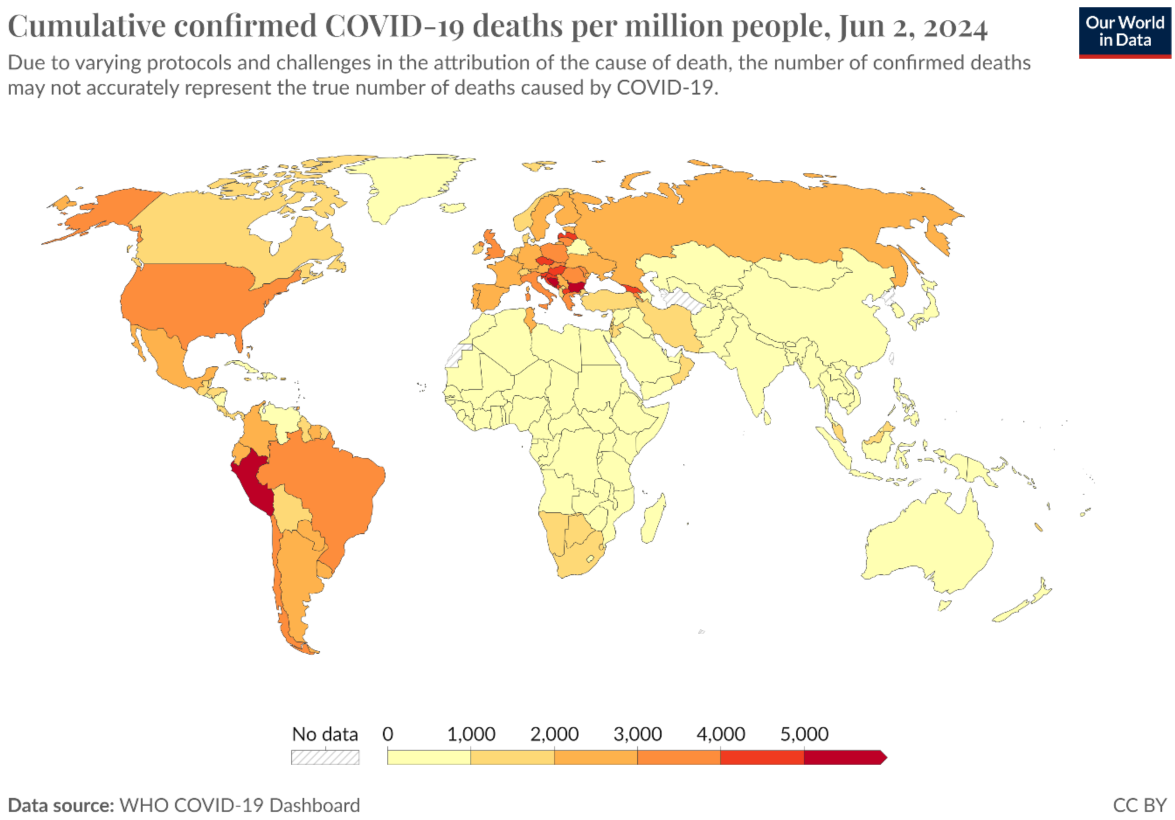


Figure 2.3: Cumulative confirmed COVID-19 deaths per million people until June 2nd, 2024 worldwide.

2.3.1.3. Vaccination Rate

Vaccination was one of the most impactful measures during the height of the global COVID-19 pandemic. Once pharmaceutical companies developed vaccines capable of preventing the disease, a significant change was observed. Despite some initial hesitation, people worldwide began receiving vaccination shots, which proved crucial for more effective disease control. As COVID-19 vaccines will continue to be vital in combating the pandemic, the policies and measures that governments implement to promote vaccination are essential (Cameron-Blake et al., 2023).

Access to vaccines remains a limitation in some regions globally. Nonetheless, many countries have been able to provide at least the first dose of the vaccine to their populations (Figure 2.4) (Privor-Dumm et al., 2023).

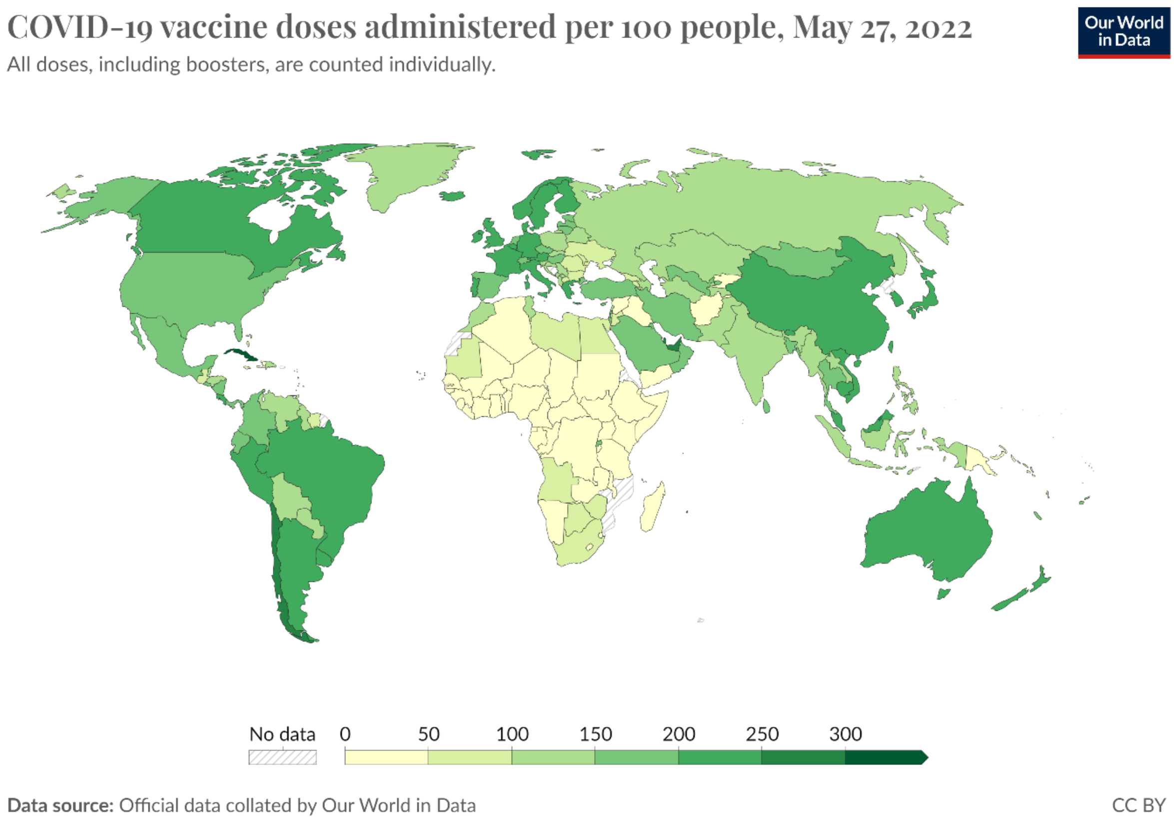


Figure 2.4: COVID-19 vaccine doses administered per 100 people on May 27th, 2022 worldwide.

2.3.2. The Global Health Security Index

Outbreaks of infectious diseases pose significant threats to human health and security. Therefore, countries with robust capabilities in prevention, detection, and response to these outbreaks can mitigate their negative impact on social, political, economic, and healthcare systems. The Global Health Security Index (GHSI) is a project developed by the Nuclear Threat Initiative and the Johns Hopkins University Center for Health Security. It was the first assessment of health security that related capacities of 195 countries worldwide. This Index aims to assist stakeholders involved in health security in identifying areas of weakness as well as opportunities for collaboration between sectors that collectively strengthen healthcare systems and achieve shared public health goals (Ravi et al., 2020).

The Index is composed by six core categories, namely Prevention of Emergency, Detection and Report, Rapid Response, Health System, Compliance with International Norms, and finally, Risk Environment (Johns Hopkins Center for Health Security et al., 2021).

2.3.2.1. Prevention of Emergence

The first category of the GHSI focuses on preventing the emergence (PE) or release of pathogenic agents, including those posing an extraordinary risk to public health, as per the internationally recognized definition of a public health emergency of international concern. Indicators in this category assess factors such as antimicrobial resistance, zoonotic diseases, biosafety, dual-use research, responsible science culture, and immunization. The global average score for this category is 28,4 out of 100, the lowest among all six categories in the index. This indicates that countries pay little to no attention to zoonotic diseases—such as those caused by coronaviruses—that are transmitted from animals to humans.

Therefore, the proposed hypotheses for testing related to this PE pillar are:

H1.1. PE significantly predicts the COVID-19 incidence rate.

H1.2. PE significantly predicts the COVID-19 mortality rate.

H1.3. PE significantly predicts the COVID-19 vaccination rate.

2.3.2.2. Detection and Report

The second pillar focuses on the detection and report (DR) and emphasizes the importance of early detection and notification of epidemics that have the potential to spread beyond national or regional borders, posing international concerns. This pillar encompasses several critical indicators that highlight various deficiencies. These include weaknesses in the strength and quality of laboratory systems, inadequacies in laboratory supply chains, and gaps in surveillance and real-time communication. Additionally, it addresses the accessibility and transparency of surveillance data, the robustness of case-based research, and the capacity and expertise of the epidemiology workforce.

Therefore, the proposed hypotheses for testing related to this DR pillar are:

H2.1. DR significantly predicts the COVID-19 incidence rate.

H2.2. DR significantly predicts the COVID-19 mortality rate.

H2.3. DR significantly predicts the COVID-19 vaccination rate.

2.3.2.3. Rapid Response

The third pillar involves the rapid response (RR) and mitigation of epidemic spread. Indicators in this category assess emergency preparedness and response planning, the execution of response plans, emergency response operations, the coordination between public health and security authorities, risk communication, access to communication infrastructure, and trade and travel restrictions. In this area, 58% of countries score below average in terms of rapid response and epidemic mitigation. Only 69 countries have a comprehensive national emergency health response plan that addresses planning for multiple communicable diseases with epidemic and pandemic potential. The results reveal significant gaps in executing response plans, risk communication, and linking public health to security authorities. However, the COVID-19 pandemic has led to the development of various evolving capabilities in rapid response and mitigation of new viruses, including planning for non-pharmaceutical interventions.

Therefore, the proposed hypotheses for testing related to this RR pillar are:

H3.1. RR significantly predicts the COVID-19 incidence rate.

H3.2. RR significantly predicts the COVID-19 mortality rate.

H3.3. RR significantly predicts the COVID-19 vaccination rate.

2.3.2.4. Health Systems

This pillar focuses on ensuring that health systems (HS) are sufficient and robust enough to address the needs of the ill and safeguard healthcare workers. Indicators in this category evaluate the capacity of clinics, hospitals, and community care centres; the supply chain for health systems and healthcare workers; the availability and deployment of medical countermeasures; healthcare access; communication with healthcare workers during public health emergencies; infection control practices; and the capacity to test and approve new countermeasures. The average score for this category is 31,5 out of 100, with over 70 countries scoring in the bottom tier, highlighting inadequate capacity in health clinics, hospitals, and community centres. More than 90% of the countries studied do not have established plans, programs, or guidelines for dispensing medical countermeasures, such as vaccines and antiviral drugs, for national use during a public health emergency. Overall, the health systems category has shown little progress since 2019 and identifies significant gaps in national-level medical workforce capacity, facilities, and healthcare access.

The proposed hypotheses for testing related to this HS pillar are:

H4.1. HS significantly predicts the COVID-19 incidence rate.

H4.2. HS significantly predicts the COVID-19 mortality rate.

H4.3. HS significantly predicts the COVID-19 vaccination rate.

2.3.2.5. Compliance with International Norms

The penultimate pillar is dedicated to the compliance with international norms (CN) and evaluates commitments to improving national capacities and funding plans to address gaps and adhere to global standards. Indicators in this category assess compliance with IHR reporting, disaster risk reduction, transboundary agreements on public and animal health and emergency response, international commitments, completion and publication of WHO Joint External Evaluations and Performance of Veterinary Services assessments, funding, and commitment to sharing genetic and biological data and specimens. Twenty-three countries did not submit their IHR reports to the WHO, and only four countries have allocated funding in their national budgets to address gaps identified in their WHO Joint External Evaluation. The 2021 GHS Index highlights a lack of progress towards enhanced global coordination and a delayed commitment to international standards, which are crucial for accountability and collective action in addressing the most challenging aspects of health security. For instance, in the past three years, only 50% of countries have submitted Confidence-Building Measures to the Convention on Toxins and Biological Weapons.

Therefore, the proposed hypotheses for testing related to this CN pillar are:

H5.1. CN significantly predicts the COVID-19 incidence rate.

H5.2. CN significantly predicts the COVID-19 mortality rate.

H5.3. CN significantly predicts the COVID-19 vaccination rate.

2.3.2.6. Risk Environment

The final pillar assesses a country's risk environment (RE) and vulnerability to biological threats. Indicators in this category evaluate political and security risks, socioeconomic resilience, infrastructure adequacy, environmental risks, and public health vulnerabilities that could affect a country's ability to prevent, detect, or respond to an epidemic or pandemic. These factors also increase the likelihood of disease outbreaks crossing national borders. As demonstrated by COVID-19, elements of the national risk environment—such as power transitions, social unrest, international tensions, and trust in government health advice—can significantly impact a country's response to a public health threat. One hundred and fourteen countries show a moderate to very high risk of international disputes or tensions negatively affecting daily operations, including public services, governance, and civil society.

Therefore, the proposed hypotheses for testing related to this RE pillar are:

H6.1. RE significantly predicts the COVID-19 incidence rate.

H6.2. RE significantly predicts the COVID-19 mortality rate.

H6.3. RE significantly predicts the COVID-19 vaccination rate.

2.3.3. Conceptual Framework Construction

The GHSI shows as a valuable tool in the realm of global health security, subject to analysis in various studies as it encompasses a broad range of factors associated with the context of crisis management in health once the Index provides an analysis of the present with a view of future development through past experiences (Aitken et al., 2020) (Razavi et al., 2020). With this approach, it is intended to analyse the Index and compare it with other factors to develop suggestions and future solutions for health crisis management. The workflow will begin by analysing the relationships between the pillars, followed by adding valuable insights regarding the key differences among countries, particularly within the official WHO regions and their cultural traits. Finally, the workflow will conclude by formulating the optimal conditions that equip countries with resilient components, enabling them to effectively combat this and future pandemics.

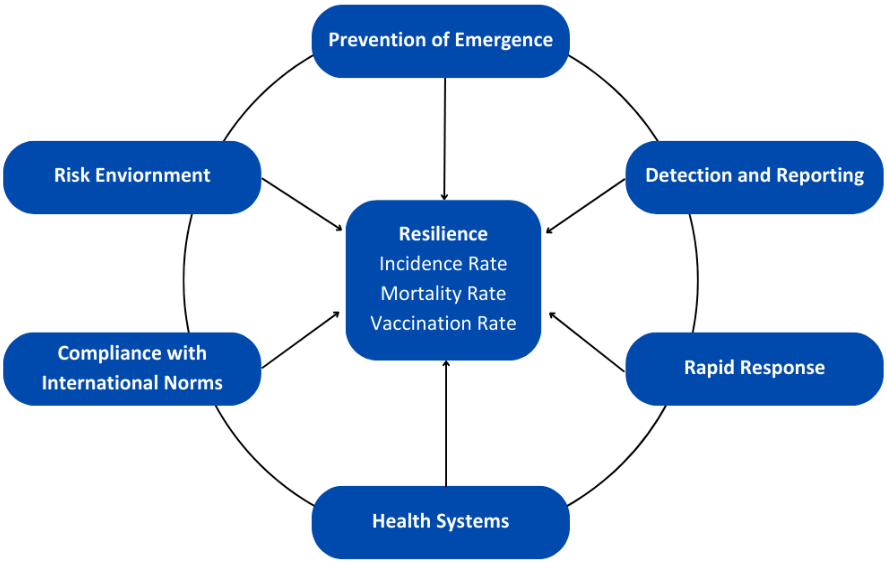


Figure 2.5: Conceptual Framework

The proposed model for the starting point of the study allows to understand if there is any influence of the variables Prevention of Emergence, Detection and Reporting, Rapid Response, Health Systems, Commitments to improving national capacity, financing and global norms, and Risk Environment on COVID-19 resilience outcomes: Incidence Rate, Mortality Rate and Vaccination Rate.

3. Methodology

3.1. Research Approach

In this study, an investigation model was built to answer the research questions and hypotheses listed in the previous chapter, namely, in the Conceptual Framework segment.

Accordingly, this chapter details the research methods employed to analyse the effectiveness of the GHSI in predicting resilience towards public health crisis, by using insights from the most recent COVID-19 pandemic. The methodology section outlines the research approach, research design, data sources, data collection method, sampling methods, data analysis method, quality criteria and limitations.

This is a deductive study, meaning that the stated hypotheses are based on existent theories and other author's previous published research (Woiceshyn & Daellenbach, 2018). The deduction method involves moving from the general to the specific, beginning with a theory that leads to the formulation of a hypothesis (Wilson, 2014), as demonstrated in the previous chapter, and their respective testing.

For data collection this study relied on secondary data. Secondary data refers to information originally collected by someone else for primary use, rather than by the author of this study (Kelly et al., 2024). The secondary resources consisted of bibliographic research that encompasses scientific articles, magazines, books and websites. By using this method, it was possible to collect the databases related to the scores of the GHSI pillars, the Incidence, Mortality and Vaccination rates of COVID-19 infection and insights from the cultural dimensions.

This study utilized a quantitative research design, in its correlational facet, employing multiple regression analysis to assess the strength and direction of the relationship between GHSI scores and COVID-19 outcomes. Quantitative research aims to measure and quantify data, focusing primarily on objectivity. It utilizes a sample of the population, with the resulting data processed using specialized software (Barroga & Matanguihan, 2022), in this study's case, the Microsoft Excel. In this thesis, databases related to the GHSI pillars and the Incidence, Mortality and Vaccination rates of COVID-19 were used as quantitative method.

Regarding the type of investigation, this study is classified as predictive research because it tested various variables to determine if and how they predict COVID-19 resilience outcomes. Additionally, it is a sequential explanatory investigation, using qualitative data from other studies to support the quantitative analysis (Bouwmeester et al., 2012).

A multiple regression model is constructed to evaluate the predictive power of GHSI pillar scores on all of the three of the COVID-19 resilience representative outcomes.

The linear regression model is specified as follows (Marôco, 2018):

$$\text{COVID-19 Infection Rate} = \beta 0 + \beta 1(PE) + \beta 2(DR) + \beta 3(RR) + \beta 4(HS) + \beta 5(CN) + \beta 6(RE) + \epsilon \quad (3.1)$$

$$\text{COVID-19 Mortality Rate} = \beta 0 + \beta 1(PE) + \beta 2(DR) + \beta 3(RR) + \beta 4(HS) + \beta 5(CN) + \beta 6(RE) + \epsilon \quad (3.2)$$

$$\text{COVID-19 Vaccination Rate} = \beta 0 + \beta 1(PE) + \beta 2(DR) + \beta 3(RR) + \beta 4(HS) + \beta 5(CN) + \beta 6(RE) + \epsilon \quad (3.3)$$

Where β0 is the intercept, β1, β2, β3, β4, β5 and β6 are the regression coefficients for each of the GHSI pillar's scores, and ϵ is the error term.

In the models above PE stands for prevention of emergence, DR for detection and response, RR for rapid response, HS for health systems, CN for compliance with international norms and RE for risk environment.

In what concerns to the sampling technique, it can be broadly categorized into probabilistic and non-probabilistic methods. Probabilistic sampling ensures that each member of the population has an equal chance of being selected, essentially meaning the selection is random. On the other hand, non-probabilistic sampling relies on specific criteria determined by the nature of the investigation, resulting in certain population members being more likely to be chosen than others (Daniel, 2012). Regarding this study, a non-probabilistic technique was used due to the selection specific members of the population.

There are several methods to choose samples in investigation procedures. The sample is a subset of the population that is actually observed. In this study, the population corresponded to all countries around the globe. Since some countries have been eliminated due to incomplete data whether because not all scores of the Index were evaluated in every country, or because certain countries where not present in at least one of the GHSI, Incidence rate, Mortality rate or Vaccination rate databases, the sample was chosen by convenience. This method involves selecting a sample based on ease of access and availability of data rather than random selection, in this case, it included countries that had complete and consistent data across the databases used. Convenience Sampling is often used in research where it is not possible to obtain data from the entire population due to practical constraints such as time, cost, or availability of information (Lohr, 2019).

3.2. Sample Characterization

As mentioned above, the population of this study is comprised of all countries worldwide. Different responses and consequences to actions were observed in countries from the four corners of the world and this is why the population englobes all of them instead of only a certain part of them.

In the end, after applying the sampling method described a total of 180 were considered, divided in the six official WHO regions: 49 countries from Europe, 43 countries from Africa, 35 countries from the America Region, 23 countries from the Western Pacific, 20 countries from the Eastern Mediterranean and 10 countries from South-East Asia (Table 3.1).

Table 3.1: Number of countries per WHO Region.

WHO Official Regions	Number of countries	%
Eastern Mediterranean	20	11,11%
Europe	49	27,22%
Africa	43	23,89%
Americas	35	19,44%
Western Pacific	23	12,78%
South-East Asia	10	5,56%
Total	180	100%

Regarding each region's GHSI scores, Europe is the region that presented the higher general score with 51,56 out of a maximum of 100 points and, on the other hand, Africa showed the lowest with 29,94 out of 100. Europe also scored the highest in all the individual pillars (PE=45,94; DR=43,59; RR=44,51; HS=49,02; CN=57,05; RE=69,22). The lowest scores in the Prevention of Emergence, Rapid Response, Health System and Risk Environment pillars belong to the African region, with PE=14,87, DR=31,16, RR=19, CN=45,76 and RE=43,73. The Detection and Reporting and Commitments to Improving National Capacity, Financing and Adherence to Norms lowest scores were attributed to the Eastern Mediterranean region with 23,13 and 37,21 out of 100, respectively (Table 3.2).

Table 3.2: GHSI scores per WHO Official Region per GHSI pillar.

WHO Official Regions	General	PE	DR	RR	HS	CN	RE
Eastern Mediterranean	31,53	22,31	25,13	31,95	25,46	37,21	47,12
Europe	51,56	45,94	43,59	44,51	49,02	57,05	69,22
Africa	29,94	14,87	25,19	31,16	19,00	45,76	43,73
Americas	39,69	30,07	30,83	39,86	32,47	48,58	56,30
Western Pacific	39,96	26,06	36,75	42,20	28,15	46,09	60,43
South-East Asia	40,29	28,30	42,34	37,38	31,97	47,63	54,12
Total	39,75	29,29	33,72	38,33	32,40	48,58	56,20

Considering the COVID-19 pandemic outcomes, the region that presented the highest Incidence Rate of COVID-19 was Europe, with an average of 21 674,85 infected people per 100 000 habitants, followed by Africa, Americas, South-East Asia, Western Pacific and Eastern Mediterranean that showed

Incidence Rate of less than the half of the highest one, with 8 042,76 infections per 100 000 habitants (Table 3.3).

In what concerns to the Mortality Rate, the South-East Asia region presented the highest value with 178,95 deaths in 100 000 habitants, followed by the Americas, Africa, Europe, Western Pacific, and lastly, with the lowest COVID-19 Mortality Rate, of 55,70 deaths per 100 000 habitants, Eastern Mediterranean (Table 3.3).

Regarding Vaccination Rate, although it is presented per 100, values over 100 are exhibited. This occurs because this rate approaches the number of administered doses. Considering that several Vaccines include booster doses, these are also englobed individually in the Rate. South-East Asia shows the higher Vaccination rate among all groups with 165,46 while East Mediterranean shows the lowest with 105,37 (Table 3.3).

Table 3.3: Average of COVID-19 Incidence and Mortality Rates per WHO Official Region.

WHO Official Regions	COVID-19 Incidence Rate (per 100 000)	COVID-19 Mortality Rate (per 100 000)	COVID-19 Vaccination Rate (per 100)
Eastern Mediterranean	8 042,67	55,70	105,37
Europe	21 674,85	117,53	158,48
Africa	21 210,63	142,34	141,82
Americas	20 971,92	146,14	165,58
Western Pacific	11 694,22	125,41	155,55
South-East Asia	15 258,88	178,95	165,46
Total	17 523,26	126,92	149,99

3.3. Quantitative Study

To collect data to carry out the present study online research through pandemic and healthcare management available sources was held. The independent variables were the GHSI pillar scores of the 2021 version. These scores are sourced from the NTI and the Johns Hopkings Center for Health Security, which collaboratively develop the GHSI. Regarding the COVID-19 outcomes, Incidence Rate and Mortality Rate are based on the number of infection or dead citizens of each country per 100 000 populations, while Vaccination Rate is based on the number of vaccination doses administered per 100 people, and are sourced from the official WHO database, covering a period from January 2020 to December 2021. Both sources represent reputable organizations. Thus, it was possible to determine whether the pillars have a predictive power or not related to the countries' resilience toward unexpected health crisis.

Before proceeding to the actual data analysis through statistic methods, a literature review was conducted considering the variables and sample that would take part of it. Besides, the use of other authors' point of views and investigations enhances the reliability and quality of the results. The ensuring, the consistency and stability of the data sources, namely by using public and official data also guarantees the reliability and transparency of this study. Another measure ensuring the quality of information in this dissertation is the rigorous selection of articles from scientific journals indexed in the SCImago Journal Rank across different quality classification. Of the total of 79 articles used to support this dissertation, the majority of them (81%) are Q1 (top-ranked journals), 10 articles, corresponding to 13% of the articles are Q2, 4 of them are Q3, and only 1 is for Q4, in its year of publication (Table 3.4). This approach prioritizes articles from the highest-rated journals on the platform.

Table 3.4: Distribution of the cited articles by the Scimago Journal & Country Rank classification.

Classification	Number of articles	%
Q1	68	81%
Q2	10	13%
Q3	4	5%
Q4	1	1%
Total	79	100%

For the data analysis conducted, the software selected was Microsoft Excel, a robust software tool capable of performing detailed data analysis and facilitating necessary comparisons.

The limitations acknowledged in this study involve data Quality and Availability once the accuracy of COVID-19 outcome data may vary across countries due to differences in testing, reporting, and healthcare infrastructure. This could introduce bias or measurement error into the analysis. Additionally, the sampling method (convenience sampling), can also represent a limitation once it may affect the generalizability of the findings to the entire population of countries.

4. Results and discussion

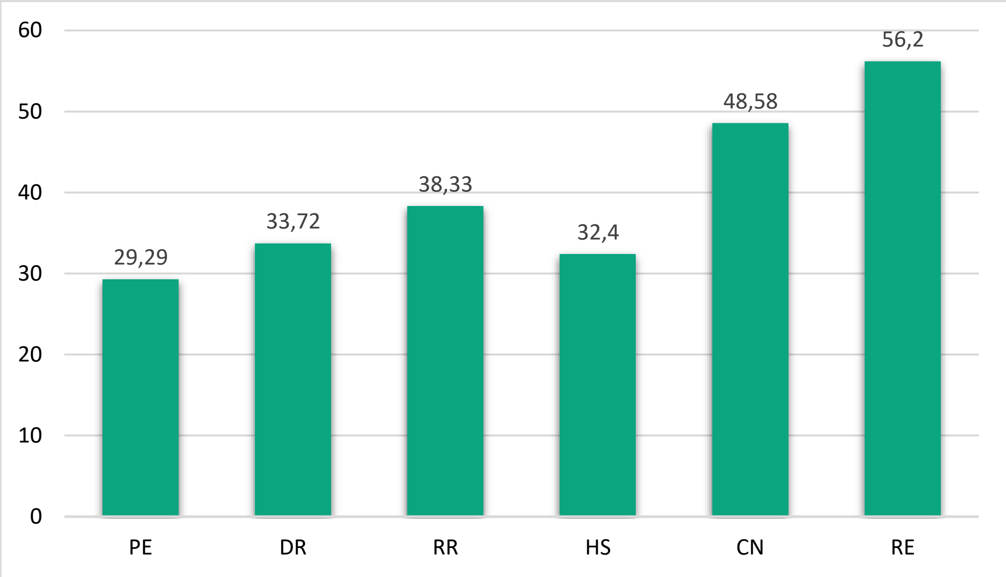
To evaluate the capacity of the GHSI pillars to predict a country's resilience to a health crisis multiple regression analyses were performed. These analyses examined the relationship between the GHSI 2021 pillars and the COVID-19 outcomes, specifically Incidence, Mortality and Vaccination Rates related to the infection. The data of Incidence and Mortality Rates, expressed as the number of cases and deaths per 100 000 people, was collected from December 31, 2019, to March 21, 2020. The study encompassed a total of 180 countries, distributed across the six official WHO regions as follows: 20 countries in the Eastern Mediterranean region, 49 in the European region, 43 in the African region, 35 in the Americas region, 23 in the Western Pacific region, and 10 in the South-East Asia region (Table 4.1).

The overall average score for all participating countries in this study was 39,75% (Table 4.1). This low average highlights a widespread lack of preparedness among countries to manage public health crises caused by transmissible infectious diseases.

Table 4.1: GHSI General score, Incidence Rate, Mortality Rate and Vaccination Rate per WHO Official Region.

WHO official Regions	n	GHSI General	Incidence Rate (per 100 000)	%	Mortality Rate (per 100 000)	%	Vaccination Rate (per 100)
Eastern Mediterranean	20	31,53	8042,67	8,04	55,70	0,05	119,49
Europe	49	51,56	21674,85	21,67	117,53	0,12	179,72
Africa	43	29,94	21210,63	21,21	142,34	0,14	73,69
Americas	35	39,69	20971,92	20,97	146,14	0,15	166,40
Western Pacific	23	39,96	11694,22	11,69	125,41	0,13	213,13
South-East Asia	10	40,29	15258,88	15,26	178,95	0,18	190,82
Total	180	39,75	17523,26	17,52	126,92	0,13	149,99

Among the six pillars, the RE scored the highest total sample mean with 56,20 out of 100. This indicates that, generally, countries place greater emphasis on assessing overall risk environments and their vulnerability to biological threats. This assessment includes political and security risks, socioeconomic resilience, infrastructure adequacy, environmental risks, and other public health vulnerabilities. Conversely, the PE pillar received the lowest score, at 29,29 out of 100 (Graph 4.1). This suggests that countries are less prepared in preventing the emergence or release of pathogens, particularly those that could lead to a Public Health Emergency of International Concern. The lack of emphasis on prevention highlights a significant area of concern in global health preparedness.



Graph 4.1 - Average of each GHSI score in the participant countries.

Additionally, a significant concern highlighted by the GHSI is that four of its categories have an average score below 40 out of 100. This finding underscores the substantial deficiencies in global preparedness for health crises. Such low scores in key categories indicate that many countries are not adequately equipped to handle severe public health emergencies. This inadequacy is further reflected in the mismatched outcomes observed during the COVID-19 pandemic, as showed in the later parts of this paperwork, where high GHSI scores did not consistently correlate with better health outcomes in terms of incidence rates and mortality. The low scores suggest systemic weaknesses in critical areas such as emergency response planning, healthcare infrastructure, public health communication, and overall crisis management capabilities. These deficiencies call for urgent attention and significant improvement to enhance global resilience against future health crises. Addressing these gaps through targeted interventions and robust policy frameworks will be essential to ensure that countries are better prepared and more resilient when facing the next public health emergency.

4.4. Regression

After applying linear regression analysis between the GHSI pillars and COVID-19 outcomes, an unexpected result was observed.

In Figure 4.1, Figure 4.2 and Figure 4.3 it is possible to see the path coefficients out of the parentheses and the p-values in parentheses. Each of the three figures represent the scheme of the previous presented conceptual framework with the addition of the mentioned values above for each of the COVID-19 resilience measures: Incidence Rate, Mortality Rate and Vaccination Rate.

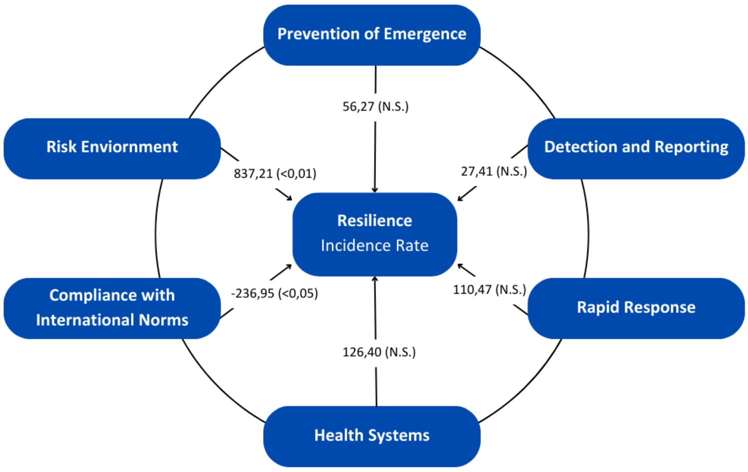


Figure 4.1: Research model with statistic results from the interaction between the GHSI pillars and the COVID-19 Incidence Rate.

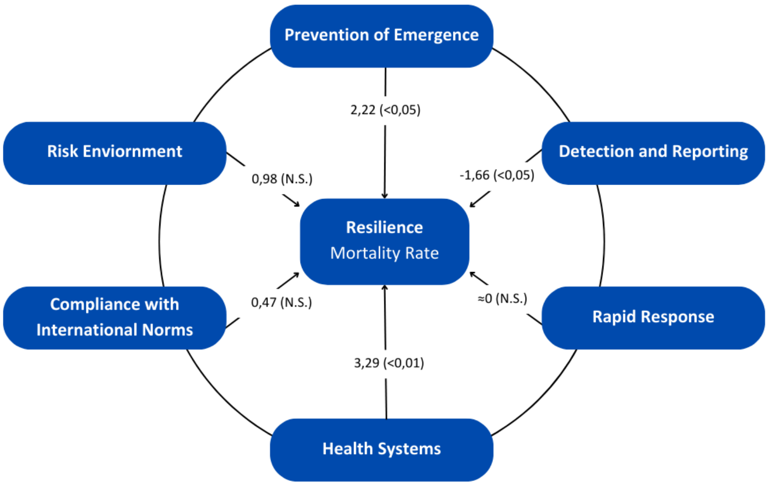


Figure 4.2: Research model with statistic results from the interaction between the GHSI pillars and the COVID-19 Mortality Rate.

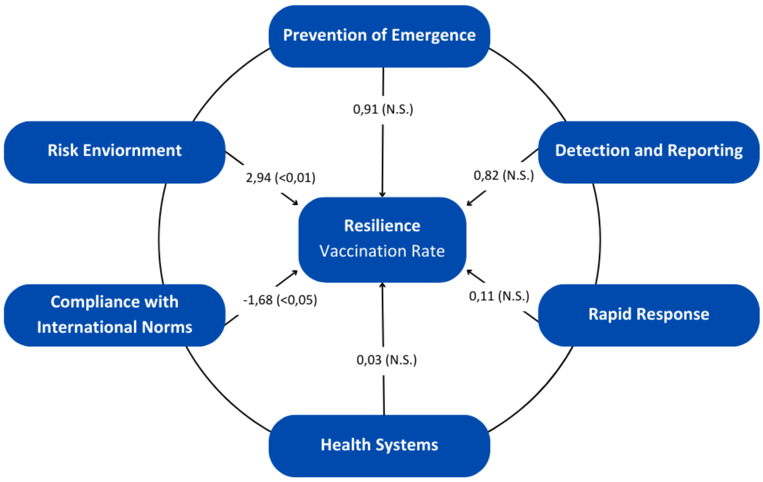


Figure 4.3: Research model with statistic results from the interaction between the GHSI pillars and the COVID-19 Vaccination Rate.

Through the analysis (Table 4.2), it is possible to observe that Compliance with International Norms has a significative negative relationship with the Incidence (β = -236,95; $p < 0,05$) and Vaccination (β = -1,68; $p < 0,01$) rates. Also, Detection and Reporting shows a significative negative effect on the Mortality (β = -1,66; $p < 0,05$).

The opposite effect was observed in the Risk Environment pillar, which has a significative positive relationship with the Incidence (β = 837,21; $p < 0,01$) and Vaccination (β = 2,94; $p < 0,01$). Regarding the Prevention of Emergence, it showed a significative effect on the Mortality (β = 2,22; $p < 0,05$). The Health System pillar also has a significative positive effect on Mortality (β = 3,29; $p < 0,01$).

On the other hand, Rapid Response does not have a significative effect in any of the rates. None of the Prevention of Emergence, Detection and Response and Health System pillars show a significative effect on both Incidence and Vaccination rates, while the Compliance with International Norms and Risk Environment pillars show a significative effect on the Mortality rate.

Table 4.2: Statistic Regression values regarding the dependent and independent variables.

GHSI Pillar	COVID-19 resilience indicators	Path Coefficient	Standard Deviation	T Statistics	*p*-values
	Incidence Rate	56,27	119,62	0,47	N.S.
PE	Mortality Rate	**2,22**	**0,95**	**2,34**	**<0,05**
	Vaccination Rate	0,91	0,54	1,70	N.S.
	Incidence Rate	27,41	96,55	0,28	N.S.
DR	Mortality Rate	**-1,66**	**0,77**	**-2,17**	**<0,05**
	Vaccination Rate	0,82	0,43	1,90	N.S.
	Incidence Rate	110,47	133,44	0,83	N.S.
RR	Mortality Rate	0,00	1,06	0,00	N.S.
	Vaccination Rate	0,11	0,60	0,18	N.S.
	Incidence Rate	126,40	116,00	1,09	N.S.
HS	Mortality Rate	**3,29**	**0,92**	**3,57**	**<0,01**
	Vaccination Rate	0,04	0,52	0,07	N.S.
	Incidence Rate	**-236,95**	**105,37**	**-2,25**	**<0,05**
CN	Mortality Rate	0,47	0,84	0,56	N.S.
	Vaccination Rate	**-1,68**	**0,47**	**-3,56**	**<0,01**
	Incidence Rate	**837,21**	**94,74**	**8,84**	**<0,01**
RE	Mortality Rate	0,98	0,75	1,31	N.S.
	Vaccination Rate	**2,94**	**0,42**	**6,93**	**<0,01**

Based on the analysis of the results, it is possible to accept or reject each of the previously stated hypotheses. The table below (Table 4.3) presents each hypothesis alongside its corresponding β value and statistical significance, which informs the decision to accept or reject the hypothesis.

Table 4.3: Studied hypotheses and respective decision of accepted or rejected.

Hypotheses	β	*p*-value	Decision
H1.1 PE significantly explains the COVID-19 incidence rate.	56,27	N.S.	Rejected
H1.2 PE significantly explains the COVID-19 mortality rate.	**2,22**	**<0,05**	**Accepted**
H1.3 PE significantly explains the COVID-19 vaccination rate.	0,91	N.S.	Rejected
H2.1 DR significantly explains the COVID-19 incidence rate.	27,41	N.S.	Rejected
H2.2 DR significantly explains the COVID-19 mortality rate.	**-1,66**	**<0,05**	**Accepted**
H2.3 DR significantly explains the COVID-19 vaccination rate.	0,82	N.S.	Rejected
H3.1 RR significantly explains the COVID-19 incidence rate.	110,47	N.S.	Rejected
H3.2 RR significantly explains the COVID-19 mortality rate.	0,00	N.S.	Rejected
H3.3 RR significantly explains the COVID-19 vaccination rate.	0,11	N.S.	Rejected
H4.1 HS significantly explains the COVID-19 incidence rate.	126,40	N.S.	Rejected
H4.2 HS significantly explains the COVID-19 mortality rate.	**3,29**	**<0,01**	**Accepted**
H4.3 HS significantly explains the COVID-19 vaccination rate.	0,04	N.S.	Rejected
H5.1 CN significantly explains the COVID-19 incidence rate.	**-236,95**	**<0,05**	**Accepted**
H5.2 CN significantly explains the COVID-19 mortality rate.	0,47	N.S.	Rejected
H5.3 CN significantly explains the COVID-19 vaccination rate.	**-1,68**	**<0,01**	**Accepted**
H6.1 RE significantly explains the COVID-19 incidence rate.	**837,21**	**<0,01**	**Accepted**
H6.2 RE significantly explains the COVID-19 mortality rate.	0,98	N.S.	Rejected
H6.3 RE significantly explains the COVID-19 vaccination rate.	**2,94**	**<0,01**	**Accepted**

This model examines the influence of PE, DR, RR, HS, CN and RE into Incidence, Mortality and Vaccination related to the COVID-19.

Answering directly to the research question, what influences the countries' resilience in managing an unexpected health crisis, namely COVID-19: 1) efforts on detecting and reporting explain the Mortality rate, 2) compliance with international norms explains the incidence of the disease, and 3) the risk environment explains the number of administered doses of the vaccine. These were the relationships that this study was looking for: where higher preparedness scores match better resilience, translated in lower incidence and mortality and high vaccinations. Therefore, significative negative relationships in terms of incidence and mortality and significative positive relationships in what concerns to vaccination were expected.

Considering all the hypnotises previously created, it is observed that higher concern of PE in terms of antimicrobial resistance and control, attention to zoonotic diseases/pathogens and biosecurity explains the countries' resilience in dealing with an unexpected health crisis (Pariente, 2022) (Reaser et al., 2024). For PE, three hypotheses were defined to predict incidence (**H1.1**), mortality (**H1.2**) and vaccination (**H1.3**) The results of the present study are not in accordance with the mentioned authors' conclusions. The study's quantitative results find a significative positive relationship only in the mortality rate (β = 2,22; *p* < 0,05), and no significant relationship with the other two. Surprisingly, the data showed a contradictory result: a positive relationship between the pillar score and mortality rate. Specifically, for each one-unit increase in the pillar score, the mortality rate increased by 2,22 units. This indicates that, controversially, higher scores in this GHSI pillar were associated with higher mortality rates, contrary to what one would expect if the pillar were effectively predicting and contributing to better health security outcomes. This finding may be of interest for future studies, given that pandemics often involve unpredictable factors that can result in high mortality rates and these factors are not being properly addressed. This contradiction reinforces the critics pointed by authors that defend that the GHSI may fail in predicting the pandemic's outcomes (Mahajan, 2021).

Regarding the Detection and Reporting pillar, theory suggests that rapid detection and reporting of cases are essential for implementing effective public health measures and preventing large-scale outbreaks, and thereby building more resilient systems (Dhaka et al., 2021). In this study, the hypotheses testing the relationship between the DR pillar and COVID-19 associated mortality rate (**H2.2**) was accepted (β = -1,66; *p* < 0,05), aligning with what the literature suggests. The negative β indicates that countries with higher DR scores experienced lower mortality rates. However, the other two hypotheses related to the DR pillar (**H2.1** and **H2.3**) showed no significant influence on countries' resilience in terms of incidence rate and vaccination rate during the COVID-19 pandemic. This means that although rapid detection and reporting were crucial for reducing mortality, the DR pillar did not significantly predict incidence or vaccination rates during the unexpected health crisis.

The following hypotheses investigated the prediction of the GHSI pillars on countries' resilience to the unexpected COVID-19 pandemic, specifically focusing on the third pillar, Rapid Response. The findings revealed no significant impact of this pillar on resilience outcomes. The hypotheses **H3.1**, **H3.2**, and **H3.3**, built around the Rapid Response pillar, did not show any statistically significant relationship with the measured resilience outcomes. This comprehensive analysis aimed to evaluate how rapid response to and mitigation of the spread of an epidemic, as defined by the GHSI, correlated with countries' ability to manage and mitigate the effects of COVID-19. The results indicated that the Rapid Response pillar of the GHSI did not play a determinative role in the resilience demonstrated by nations in response to the pandemic.

In terms of Health Systems, the literature evidence claims that sufficient and robust health systems to treat the sick and protect the healthcare workers must be a focal point to have in consideration to deal with unexpected health crises (Mustafa, 2022). Consequently, from the present analysis, from all of the three developed hypotheses that connects the fourth GHSI pillar of Health Systems with the resilience representative pandemic outcomes, only the one related to mortality is significative. The hypotheses that studies if HS was significative related COVID-19 mortality rate, **H4.2**, was accepted (β = 3,29; $p < 0{,}01$). It, however, presented a positive relationship once β > 0. With these results, it becomes evident that according to the GHSI versus the actual outcomes of the pandemic, the HS pillar of the GHSI was not a reliable predictor of COVID-19 outcomes. Surprisingly, the data showed a contradictory result: a positive relationship between the pillar score and mortality rate. Specifically, for each one-unit increase in the pillar score, the mortality rate increased by 3,29 units. This indicates that higher scores in this GHSI pillar were associated with higher mortality rates, contrary to what would be expect if the pillar was effectively predicting and contributing to better health security outcomes. The other two rates that related the HS pillar to the countries' COVID-19 resilience, specifically incidence and mortality rates (**H4.1** and **H4.3**) did not present a significative influence. The results of this pillar showed that, once again, the GHSI may fail in predicting the pandemic's outcomes (Mahajan, 2021).

The literature emphasizes that collaborative and complementary efforts, multisectoral coordination, and comprehensive engagement from local to international levels are essential for building resilience in managing outbreaks (Doble et al., 2023). In this study, three hypotheses were tested regarding the relationship between compliance with international norms and COVID-19 outcomes. Two of these hypotheses showed significant results. The first hypothesis (**H5.1**) concerning the incidence rate was accepted (β = -236,95; $p < 0{,}05$), indicating a stronger commitment to enhancing national capacity, financing plans to address gaps, and adhering to global norms is linked to lower COVID-19 incidence rates. The second accepted hypothesis (**H5.3**) related to the vaccination rate (β = -1,68; $p < 0{,}01$) showed that high compliance with international norms is associated with a lower vaccination rate. This suggests a negative relationship between CN and vaccination rates. As already mentioned, a negative relationship, where higher values of the pillar correspond to lower vaccination rates is not expected. If this pillar could effectively predict resilience in the vaccination sphere, a positive relationship between the two variables would be found. The remaining hypothesis, regarding the impact of the compliance with international norms pillar on the mortality rate (**H5.2**), did not show significant evidence of influence, either positively or negatively.

Research consistently indicates that countries with more intrinsic risk factors—such as socioeconomic inequalities, limited healthcare access, and higher social vulnerabilities—tend to experience a greater burden of COVID-19. These nations often see higher rates of virus transmission, increased mortality, and lower vaccination coverage. Such findings underscore the critical need for addressing underlying social determinants of health to mitigate the impacts of pandemics (Chang et al., 2022) (Ngatu et al., 2022). Regarding this last pillar, two of the three hypotheses are accepted. In terms of the RE pillar prediction power towards incidence (**H6.1**) the hypothesis was accepted (β = 837,21; $p < 0{,}01$), but it must be considered the positive value of β indicating that higher RE scores correspond to countries with also higher COVID-19 incidence rates, which diminishes the predictive power of the RE pillar in this context and reinforces the unreliability of the GHSI to determine the countries' resilience towards a health crisis. Also, the hypothesis relating this last pillar with the amount of COVID-19 administered vaccine doses (**H6.3**) was accepted (β = 2,94; p < 0,01). The significant positive relationship means that higher RE scores are associated with higher vaccination rates, indicating that this pillar effectively predicts a country's resilience in terms of vaccination efforts. The hypothesis examining the relationship between the RE pillar and COVID-19 mortality rates did not show a significant positive or negative relationship.

4.5. Comparison between geographic groups

It is crucial to highlight some key findings from the analyses. When combined, the average scores across all GHSI pillars do not reach 40%. This indicates that even if some countries were able to rapidly develop capacities to address COVID-19, all countries remain dangerously unprepared for future epidemic and pandemic threats (Williams et al., 2023). If countries are grouped into five levels based on their general preparedness as defined by the GHSI tiers — with each tier spanning 20 points (from 0-20 for the lowest tier to 81-100 for the highest) — no country would fall into the top tier. The most common tier among all countries in this study was the second tier, encompassing scores from 21 to 40, with more than half of the sample (n = 102) falling into this category (Table 4.4).

Table 4.4: GHSI tier distribution of the participant countries.

Tier	GHSI General score	Countries	%
1	0 – 20	4	2,2%
2	21 - 40	102	56,7%
3	41 – 60	55	30,6%
4	61 – 80	19	10,6%
5	81 - 100	0	0,0%
Total		180	100%

It was also noted that some countries with higher GHSI scores experienced more severe COVID-19 outcomes compared to some countries with lower scores. For example, the United States of America, which had the highest 2021 GHSI score, reported over 180 times more infections and approximately 40 times more deaths compared to Somalia, which had the lowest GHSI score (Table 4.5).

Table 4.5: Individual scores and outcomes rates comparison in the top and bottom three countries on the General GHSI ranking.

County	GHSI Ranking	General score	PE	DR	RR	HS	CN	RE	Incidence	Mortality	Vaccination
United States of America	1	75,9	79,4	80,1	65,7	75,2	81,9	73,3	31249,547	343,897	57,79
Australia	2	71,1	65,2	82,2	61,6	69,2	72,2	76	45720,918	92,318	107,30
Finland	3	70,9	58,2	67,5	70,7	68,7	77,8	82,6	27142,674	196.623	34,82
…	…	…	…	…	…	…	…	…	…	…	…
Syria	178	16,7	12,9	4,2	18	13,4	24,5	27,4	328,119	18,074	4,32
Yemen	179	16,1	0,8	4,2	17,5	12	37,5	24,9	40,049	7,239	74,06
Somalia	180	16	11,4	11,7	25,8	1,3	21,9	23,6	171,985	8,563	93,76

This mismatch was already described by other writers (Mahajan, 2021) (Mustafa, et al 2021) (Aitken, et al 2020) and studies on why this happen are being held.

A major criticism of the GHSI is that it doesn't fully consider the complicated political and social factors that are important for a country's public health efforts and for keeping their people healthy over time. Once built on predefined categories and standard templates, its capacity to adapt to surprises, learn from rapidly changing events, and capture relationships that change over time and involve social learning is limited. It presents its conclusions and recommendations in a one-size-fits-all format, which means its suggestions are not tailored to the specific situations and contexts of each country or region (Mahajan, 2021).

When analysing the output, the scores of the WHO official regions with the COVID-19 outcomes, the described inconsistency in noticeable. The biggest Incidence Rate was seen in same region that presented the highest GHSI score, and therefore, supposedly, a higher capacity and preparedness toward health crises: the Europe Region. The same is observed in what concerns to Mortality. Regarding Vaccination, the region with more administered doses was the Western Pacific, which presented the third lower general score (Table 4.5).

To better understand these inconsistencies and to determine if there are statistically significant differences among the WHO regions in terms of their GHSI pillars, a Kruskal-Wallis test was conducted. The results of the test reveal that there are significant differences among the groups in all of the GHSI pillars. The exact nature of these differences (i.e., which groups are different from each other) requires additional post-hoc testing. For this a Dunn-Bonferroni-Tests were conducted.

It was observed that all of the pillars present significant differences between the WHO Official Regions in all of the GHSI pillars (Table 4.6).

Table 4.6: Dunn-Bonferroni-Tests results of significant different groups among each GHSI pillar.

GHSI Pillar	WHO Official Regions	Test Statistic	*p*-value
PE	Eastern Mediterranean - Europe	-66,73	<,001
	Europe - Africa	93,21	<,001
	Europe - Americas	45,34	<,001
	Europe - Western Pacific	59,22	<,001
	Europe - Western Pacific	59,22	<,001
DR	Eastern Mediterranean - Europe	-49,93	<,001
	Europe - Africa	49,89	<,001
RR	Eastern Mediterranean - Europe	-56,56	<,001
	Europe - Africa	64,01	<,001
	Africa - Western Pacific	-53,45	<,001
HS	Eastern Mediterranean - Europe	-63,41	<,001
	Europe - Africa	81,78	<,001
	Europe - Americas	49,08	<,001
	Europe - Western Pacific	62,93	<,001
CN	Eastern Mediterranean - Europe	-80,18	<,001
	Europe - Africa	47,17	<,001
RE	Eastern Mediterranean - Europe	-71,37	<,001
	Europe - Africa	88,04	<,001
	Europe - Americas	42,3	<,001
	Africa - Western Pacific	-60,47	<,001

In the Dunn-Bonferroni tests (Table 4.6) the specific differences between each pillar per each region are demonstrated.

Across all pillars, the Eastern Mediterranean consistently scores lower than Europe. This underperformance may be attributed to a combination of factors such as political instability, ongoing conflicts, weaker health infrastructures, and limited resources in many countries within this region. These challenges can severely impact the region's ability to prevent, detect, and respond to health crises effectively. The stark differences in the CN and RE pillars in this region are particularly concerning, as they suggest challenges in adhering to global health standards and managing health risks due to socio-political factors.

Africa’s lower scores in comparison to Europe across most pillars highlight systemic challenges such as weaker health systems, limited financial resources, and infrastructural deficits. These issues are often exacerbated by socio-economic disparities and political instability in several African countries. The test statistics show that Africa sometimes underperforms even when compared to the Western Pacific region, particularly in RR and RE. This suggests that Africa may face additional challenges in mobilizing resources and managing health risks effectively compared to the Western Pacific, which includes countries with a range of economic statuses but generally more stable health infrastructures.

Europe's higher scores in the PE, HS, and RE pillars when compared to the Americas suggest that, despite the presence of strong health systems in countries like the United States and Canada, the Americas as a whole may face disparities in health security, particularly in Latin America where health infrastructures can be less developed. The Americas' performance being better than some regions but not as strong as Europe suggests a mixed scenario where some countries in the region may have robust health security measures while others are more vulnerable.

The results underscore significant disparities in global health security, with Europe generally leading in preparedness, response, and resilience. These differences can be attributed to a combination of factors, including economic development, political stability, health infrastructure, and governance quality.

The variation in scores across regions suggests that a one-size-fits-all approach to global health security may not be effective. Instead, interventions need to be tailored to the specific needs and challenges of each region, with a focus on building capacity in weaker areas.

The differences in the CN pillar highlight the need for stronger international cooperation and support to ensure that all regions adhere to global health standards and are better prepared for future health crises.

4.6. Culture role during the pandemic

In the first part of the analysis, was studied which categories of the GHSI better predict the resilience capacity of the countries towards unexpected health crises, namely in the case of the COVID-19 pandemic. Then a comparison between the geographical groups was approached.

Considering those factors, the effectiveness of this Index remains doubtable with most of the pillars not showing significative relationships of better index score leading to better resilience. As said, part of the mentioned critics about GHSI is the low to no consideration about factors such as experience, adaptability capacity and social factors (Aitken et al., 2020). These factors can be reflected in the several cultural dimensions approached in the literature review.

To minimize disruptions in health services and the resulting excess mortality and morbidity during health emergencies, countries must incorporate context-specific considerations into their ongoing and future emergency planning. This involves embedding strategies for maintaining quality, routine, and essential health services within emergency preparedness and response plans. Special attention should be given to local epidemiology by identifying gaps and vulnerabilities in health system capacity and assessing the severity of disruptions caused by crises. This assessment should draw on both past and current public health emergencies, incorporating relevant evaluations and reviews (Mustafa, 2022).

According to Hofstede, Eastern Mediterranean countries exhibit higher **PDI** cultures. Despite consistently showing low scores on the GHSI pillars, this region showed the third lowest COVID-19 incidence rate in the present study, which supports the idea that low PDI countries tend to question experts and public health measures, often leading to lower compliance and respect for these measures. This respected is translated to better result in terms of the disease incidence once the respect for the referred measure prevents the infection from spreading across the communities (Dheer et al., 2021).

In line with Hofstede scores, **UA** tends to be higher in East and Central European countries, in Latin countries, in Japan and in German speaking countries, lower in English speaking, Nordic and Chinese countries. Europe, for example, with high UA scores, presented hight incidence and mortality rates comparing to the other groups, which is consistent with the authors that mention that nations with this kind of culture were more harmed by the pandemic. However, the vaccination rate shows a good connection to this type of culture because of worries about the severe consequences of SARS-CoV-2 infection. People in cultures with a higher concern for uncertainty tend to believe that vaccination lowers the risk of adverse effects, thereby reducing uncertainty (Lajunen et al., 2022).

Hofstede's scores suggest that **IDV** tends to prevail in developed and Western countries, while collectivism is more common in less developed and Eastern countries. This pattern is evident as Europe, the Americas, and the Western Pacific—regions representing Western countries—had the highest incidence rates of COVID-19. Despite many of these countries being considered developed and wealthy OECD nations, they were not able to control the spread of infections as effectively as other regions. This is in accordance with the findings reported by other authors, who defends that individualist cultures are believed to exhibit worse disease outcomes during COVID-19 compared to the collectivist ones (Rajkumar, 2021).

In terms of **MAS**, the Hofstede ranking is higher in Japan, German speaking countries, and in some Latin countries like Italy and Mexico, being more moderate in English speaking Wester countries and low in Nordic countries and in the Netherlands and moderately low in some Latin and Asian countries like France, Spain, Portugal, Chile, Korea and Thailand. Considering the dispersion of the countries through this dimension, it becomes challenging to associate specific WHO regions to the described countries score of the dimension. Although, literature suggests that the number of confirmed cases and deaths is correlated with MAS (Chen & Biswas, 2022).

Analysing once again the Hofstede score, the findings point for **LTO** nations being East Asian countries, followed by Eastern- and Central Europe. A medium-term orientation is found in South- and North-European and South Asian countries. Short-term oriented are the U.S.A. and Australia, Latin American, African and Muslim countries. A curious fact about this dimension, is that the LTO regions, correspondent to Europe and South-East Asia in this study, are the ones which present higher vaccination rates, as already described by other authors (Lajunen et al., 2022). Vaccination prevents future infection and might reduce future infection symptoms, which is consistent with the LTO nations mindset.

Lastly, Hofstede mentions that **Indulgence** tends to prevail in South and North America, in Western Europe and in parts of Sub-Sahara Africa as Restraint prevails in Eastern Europe, in Asia and in the Muslim world. Comparing to the other regions it is seen that the correspondent Restraint groups present low incidence rates, being placed in the bottom three regions of less COVID-19 incidence. Once again, this is consistent with the fact that indulgent societies might experience worse COVID-19 disease outcomes. In terms of vaccination, Indulgence groups seem to present better results (Erman & Medeiros, 2021).

The African region presented a notable paradox during the COVID-19 pandemic, exhibiting some of the lowest incidence and mortality rates globally. This outcome intrigued public health investigators, especially given that Africa is characterized by low-income and less-developed countries. Several factors contribute to this phenomenon. First, demographic data revealed that African countries generally have lower median ages and life expectancies compared to other regions. Since COVID-19 mortality is higher among the elderly, the younger population in Africa is less susceptible to severe outcomes and deaths from the virus. Moreover, African populations have lower rates of comorbidities such as cardiovascular diseases, which are significant predictors of severe COVID-19 outcomes. This lower prevalence of pre-existing conditions can be partly explained by the fact that many individuals with such conditions may have already succumbed to pre-COVID-19 diseases, given the less advanced healthcare systems in many African countries. In essence, the healthcare systems in Africa, while less advanced, might have influenced the population dynamics by reducing the pool of individuals with chronic conditions that exacerbate COVID-19 mortality. In summary, Africa's low COVID-19 mortality rate can be attributed to its younger population, lower prevalence of comorbidities, and unique healthcare system dynamics. These factors collectively contribute to the region's relatively better outcomes in terms of COVID-19 mortality (Lawal, 2021).

4.7. Summary

The COVID-19 pandemic was an unprecedented global event that swiftly altered daily life and societal perspectives. In a matter of months, it revealed both the strengths and significant flaws in global management systems. At the time of writing this dissertation COVID-19 cases persist worldwide, but it is no longer considered a global threat.

Experience and history demonstrate that unexpected health crises are recurrent and will continue to occur. To mitigate the negative impacts seen in recent pandemics, the world must be better prepared. Governments and decision-makers should not become complacent as COVID-19 wanes. Instead, they must continue monitoring the situation and develop new strategic plans to address future health crises effectively.

Every crisis is unique, making it challenging to create standard response plans that guarantee minimal impact. Nonetheless, efforts are being made to develop indices that assess a country's preparedness for health crises. This dissertation references such an effort by the Johns Hopkins Center for Health Security, which in collaboration with other initiatives, created the GHSI. The index is based on six essential pillars: PE, DR, RR, HS, CN, RE.

In the initial stage of the quantitative analysis, it was found that the DR pillar has significant predictive power concerning the COVID-19 Mortality Rate. Specifically, a negative coefficient (β =-1,66) indicates that higher DR scores are associated with lower Mortality Rates ($p < 0{,}05$).

Similar findings were observed with the CN pillar, which showed predictive power regarding the countries' COVID-19 Incidence Rates. The analysis revealed a negative relationship between these variables (β = -236,95) with a significant p-value ($p < 0{,}05$). This suggests that countries with higher CN pillar scores tend to have lower incidence rates of COVID-19 infections within their populations.

The capacity for countries to mitigate the virus via pharmaceutical measures, by vaccinating the population, was predicted, according to the statistical results, by the level of RE presented by the countries. The hypothesis that approached this possibility showed a positive relationship (β = 2,94) statistically significative ($p < 0{,}01$). This represents those countries with higher RE scores, which had a better response in terms of vaccine doses administrated in their population.

Other significative relationships were observed, specifically between both the PE and HS pillars and mortality and the CN pillar and the dependent variable vaccination. Nevertheless, the relationships were contradictory as they suggest that a better pillar score leads to a worst outcome.

From all of the six GHSI pillars, only the DR pillar, CN pillar and RE pillar had a predictive power upon the COVID-19 outcomes. The capacity of the Index to predict the resilience presented by the countries when faced by a health crisis is, according to this and other investigations (Mahajan, 2021) (Ravi et al., 2020) (Aitken, et al 2020) (Razavi et al., 2020), limited. The relationships found between some pillars and the resilience measures were not only not significative, but also contradictory.

The obtained results from the regression analysis reinforces that while developing strategic response plans and during decision-making by public health authorities, activities related to Detection and Reporting, Compliance with International Norms and Risk Environment must be prioritized and taken into account. Detection and Reporting ensure early identification and response to outbreaks, while compliance with international norms fosters global coordination and best practice implementation. Understanding the Risk Environment helps tailor interventions to specific challenges and vulnerabilities. Integrating these factors enables authorities to deploy resources efficiently, mitigate disease spread, and safeguard public health effectively.

By dividing the countries into the official WHO regions, noticeable differences emerge in both their GHSI scores and their resilience to the pandemic. It was observed that countries with higher GHSI scores did not necessarily achieve better COVID-19 outcomes, highlighting once again weaknesses in the GHSI prediction power. This disparity was particularly evident in regions like Europe and Africa. The results underscored significant disparities in global health security, with Europe generally leading in preparedness, response, and resilience due to factors such as economic development, political stability, robust health infrastructure, and governance quality. Nevertheless, this region experienced the worst outcomes in terms of COVID-19 incidence and mortality. Conversely, Africa, which had the lowest scores in most pillars, surprisingly showed the least impact from COVID-19 regarding incidence and mortality levels. The variation in scores across regions indicates that the one-size-fits-all approach to health security is insufficient, emphasizing the need for tailored interventions that address the specific challenges of each region, particularly in building capacity in weaker areas.

To understand why these considerable marked differences were seen, a subjective comparison and analyses was pursuit. This comparison was done based on the cultural differences perceived in each region in the globe. Countries show an enormous diversity of cultural traits that influence the way communities behave and interact. For this reason, people’s reactions were diverse when facing the pandemic, whether about the monitoring of the infections, the restrictions measures or the long-term and pharmaceutical approaches. This study reinforces the findings of other authors relatively to the reactions of populations to COVID-19 depending on their cultural dimension scores (Chen & Biswas, 2022) (Dheer et al., 2021) (Lajunen et al., 2022) (Rajkumar, 2021) (Erman & Medeiros, 2021).

For instance, cultures with higher PDI, tend to present less incidence of the virus once the population does not tend to question experts and public health measures as wearing masks and keeping the social distance. Nations characterized by high UA usually present worst COVID-19 incidence and mortality rates, but with good result in vaccination rates once vaccination reduces the likelihood of adverse effects and, thus, uncertainty. Individualistic cultures are strongly described in studies of this nature to being more affected by the COVID-19 pandemic once this kind of culture is more likely to violate public health norms such as by engaging in large maskless protests against mandates or lockdowns in which little social distance is maintained (Rajkumar, 2021). It is even recommended that leaders should try to foster a more collectivistic mindset among their constituents regarding promoting safe conduct during the current pandemic or future ones (Maaravi et al., 2021).

In terms of LTO, the subjective analysis of this study detects a possible connection between countries with high LTO and vaccination rates. This goes in accordance with literature, which finds a statistically significant relationship between vaccination and LTO, although Countries with a higher score in LTO applied less stringent COVID-19 policies (Lajunen et al., 2022). The higher ranked IVR nation tend to show higher incidence of COVID-19 infections. However, as described in literature, they present better result in what concerns to the amount of vaccine doses administered (Erman & Medeiros, 2021).

5. Conclusions

The present study aimed to evaluate the reliability of the GHSI and its capacity to predict countries' preparedness and resilience to face health crises specifically by the use of data retrieved from COVID-19 outcomes. This research purposed to uncover whether the GHSI can accurately predict the effectiveness of a country's response to a public health emergency and to identify additional factors, like cultural dimensions, that may significantly influence a country's resilience.

Our findings emphasize several focal points that are to be considered and integrated when constructing and developing actions and decision-making plans in health crises management:

a) Detection and Reporting (DR) significantly influence the COVID-19 mortality rate in different countries. Therefore, improving DR mechanisms should be a priority when developing action plans to strengthen health system responses to future health crises;

b) Compliance with International Norms significantly affects the COVID-19 incidence rate among the studied countries. This underscores the importance of following and supporting international norms provided by various official international agencies. Governments and regulatory entities should consider these regulations in their response strategies to prevent disease spread and infections;

c) the Risk Environment intrinsic to each country influenced the number of vaccine doses administered. Although developed countries experienced some of the worst outcomes globally, they managed to achieve significant vaccination coverage. This suggests their vaccination methodologies and strategies should be shared with those with lesser performance so to improve access and speed of mass vaccination during future crises.

These focal points may provide countries a better direction and strength for possible crises that may arrive unexpectedly. In addition, implementing those points adequately may create improved capabilities in the health system and resilience than those observed during the COVID-19 pandemic.

As a matter of fact, strong and resilient countries offer more safety to their populations and avoiding deep marks and hard memories on people. These marks might not be just about infecting people and possible deaths. The impact of the pandemic on people’s life may develop in other forms such as mental health issues (like anxiety or depression), societal problems and people’s development gaps. Managing health crisis in a better way with increased resilience will be tremendously positive for societies.

In regard of limitations of the study, during the research process, there was lack of data on some countries and these were discharged from the sample. On the other hand, there were countries not providing constant flow of information, namely, regarding vaccination rates.

For further research, one could delve deeper into how specific cultural dimensions influence public compliance, policy effectiveness, and crisis communication. It could be also interesting to approach more intensively each of the three pillars with prediction power over the resilience measures in order to understand how they really relate and how they could be potentialized. At last, a review of the GHSI could be held, once the tool shows great potential not only to classify countries from worst to better preparedness but also to provide constructive insights about effective health crises management.

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7. Annexes

Annex A: Output printouts.

Descriptive statistic outputs.

	PE	DR	RR	HS	CN	RE
Mean	29,29	33,72	38,33	32,4	48,58	56,2
Median	27,05	31,1	36,35	26,6	47,05	55,85
Std. Deviation	17,74	19,6	11,93	18,44	13,22	15,1
Minimum	0,8	2,2	17,5	1,3	18,8	23,6
Maximum	79,4	91,5	70,7	75,2	81,9	89
Range	78,6	89,3	53,2	73,9	63,1	65,4

	Infection (per 100 000)	Mortality (per 100 000)	Vaccination (per 100)
Mean	17523,26	126,92	149,99
Median	9513,94	75,32	153,64
Std. Deviation	19697,48	135,47	82,06
Minimum	39,31	0,13	0,35
Maximum	74420,08	672,47	349,76
Range	74380,77	672,35	349,41

Multicollinearity

- Problematic if Tolerance < 0,10 or VIF > 10

Model	Tolerance	VIF
PE	0,22	4,58
DR	0,27	3,64
RR	0,39	2,57
HS	0,22	4,65
CN	0,51	1,97
RE	0,48	2,08

Regression output for the dependent variable COVID-19 Incidence Rate.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-28921,9	5292,704	-5,46449	1,6E-07	-39368,5	-18475,4	-39368,5	-18475,4
PE	56,26588	119,6239	0,470356	0,638693***	-179,844	292,3762	-179,844	292,3762
DR	27,41213	96,55029	0,283916	0,776815***	-163,156	217,9803	-163,156	217,9803
RR	110,4728	133,4347	0,827917	0,408858***	-152,897	373,8423	-152,897	373,8423
HS	126,403	115,9974	1,089706	0,277358***	-102,549	355,3554	-102,549	355,3554
CN	-236,95	105,3645	-2,24886	0,025783**	-444,915	-28,9846	-444,915	-28,9846
RE	837,2121	94,73708	8,837217	1,08E-15*	650,2228	1024,201	650,2228	1024,201

*1% significance level; ** 5% significance level; *** not significant

Regression output for the dependent variable COVID-19 Mortality Rate.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-66,8175	42,06174	-1,58856	0,113986	-149,838	16,20273	-149,838	16,20273
PE	2,222373	0,950665	2,337703	0,020547**	0,345977	4,09877	0,345977	4,09877
DR	-1,66162	0,767296	-2,16555	0,031715**	-3,17609	-0,14715	-3,17609	-0,14715
RR	0,000376	1,060421	0,000355	0,999717***	-2,09265	2,093404	-2,09265	2,093404
HS	3,293109	0,921845	3,572302	0,000459*	1,473598	5,11262	1,473598	5,11262
CN	0,468747	0,837344	0,559802	0,576338***	-1,18398	2,121473	-1,18398	2,121473
RE	0,982181	0,752887	1,304554	0,193778***	-0,50385	2,468207	-0,50385	2,468207

*1% significance level; ** 5% significance level; *** not significant

Regression output the dependent variable COVID-19 Vaccination Rate.

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	6,736404	23,68993	0,284357	0,776477	-40,0221	53,49492	-40,0221	53,49492
PE	0,910656	0,535432	1,700788	0,09078***	-0,14616	1,967477	-0,14616	1,967477
DR	0,820057	0,432155	1,897597	0,059415***	-0,03292	1,673032	-0,03292	1,673032
RR	0,109794	0,597248	0,183833	0,85436***	-1,06904	1,288625	-1,06904	1,288625
HS	0,034925	0,5192	0,067266	0,946447***	-0,98986	1,059706	-0,98986	1,059706
CN	-1,67709	0,471607	-3,55611	0,000486*	-2,60794	-0,74624	-2,60794	-0,74624
RE	2,936918	0,424039	6,926049	8,16E-11*	2,099961	3,773875	2,099961	3,773875

*1% significance level; ** 5% significance level; *** not significant

Annex B: Geographic correlations printouts.

Kruskal-Wallis Tests

	Chi^2	df	*p*
PE	77,72	5	<,001
DR	28,67	5	<,001
RR	43,92	5	<,001
HS	63,22	5	<,001
CN	40,87	5	<,001
RE	73,7	5	<,001

Geographic analysis for PE

	Test Statistic	Std. Error	Std. Test Statistic	*p*	Adj. *p*
Eastern Mediterranean - Europe	**-66,73**	**13,83**	**-4,83**	**<,001**	**<.001**
Eastern Mediterranean - Africa	26,49	14,1	1,88	,06	,905
Eastern Mediterranean - Americas	-21,39	14,61	-1,46	,143	1
Eastern Mediterranean - Western Pacific	-7,5	15,93	-0,47	,638	1
Eastern Mediterranean - South-East Asia	-21,97	20,18	-1,09	,276	1
Europe - Africa	**93,21**	**10,89**	**8,56**	**<,001**	**<,001**
Europe - Americas	**45,34**	**11,53**	**3,93**	**<,001**	**,001**
Europe - Western Pacific	**59,22**	**13,17**	**4,5**	**<.001**	**<,001**
Europe - South-East Asia	44,75	18,08	2,48	,013	,2
Africa - Americas	**-47,88**	**11,86**	**-4,04**	**<,001**	**,001**
Africa - Western Pacific	-33,99	13,46	-2,53	,012	,173
Africa - South-East Asia	-48,46	18,29	-2,65	,008	,121
Americas - Western Pacific	13,89	13,99	0,99	,321	1
Americas - South-East Asia	-0,59	18,68	-0,03	,975	1
Western Pacific - South-East Asia	-14,47	19,74	-0,73	,463	1

Adj. p: Values adjusted with Bonferroni correction.

Geographic analysis for DR

	Test Statistic	Std. Error	Std. Test Statistic	*p*	Adj. *p*
Eastern Mediterranean - Europe	**-49,93**	**13,83**	**-3,61**	**<,001**	**,005**
Eastern Mediterranean - Africa	-0,04	14,1	0	,998	1
Eastern Mediterranean - Americas	-11,17	14,6	-0,77	,444	1
Eastern Mediterranean - Western Pacific	-24,53	15,93	-1,54	,124	1
Eastern Mediterranean - South-East Asia	-44,42	20,18	-2,2	,028	,415
Europe - Africa	**49,89**	**10,89**	**4,58**	**<,001**	**<,001**
Europe - Americas	38,75	11,53	3,36	,001	,012
Europe - Western Pacific	25,4	13,17	1,93	,054	,807
Europe - South-East Asia	5,5	18,08	0,3	,761	1
Africa - Americas	-11,14	11,86	-0,94	,348	1
Africa - Western Pacific	-24,49	13,46	-1,82	,069	1
Africa - South-East Asia	-44,39	18,29	-2,43	,015	,229
Americas - Western Pacific	-13,35	13,99	-0,95	,34	1
Americas - South-East Asia	-33,25	18,68	-1,78	,075	1
Western Pacific - South-East Asia	-19,9	19,74	-1,01	,313	1

Adj. p: Values adjusted with Bonferroni correction.

Geographic analysis for RR

	Test Statistic	Std. Error	Std. Test Statistic	*p*	Adj. *p*
Eastern Mediterranean - Europe	**-56,56**	**13,83**	**-4,09**	**<,001**	**,001**
Eastern Mediterranean - Africa	7,45	14,1	0,53	,597	1
Eastern Mediterranean - Americas	-34,11	14,61	-2,34	,02	,293
Eastern Mediterranean - Western Pacific	-46	15,93	-2,89	,004	,058
Eastern Mediterranean - South-East Asia	-18,45	20,18	-0,91	,361	1
Europe - Africa	**64,01**	**10,89**	**5,88**	**<,001**	**<,001**
Europe - Americas	22,45	11,53	1,95	,052	,773
Europe - Western Pacific	10,56	13,17	0,8	,423	1
Europe - South-East Asia	38,11	18,08	2,11	,035	,526
Africa - Americas	**-41,56**	**11,86**	**-3,5**	**<,001**	**,007**
Africa - Western Pacific	**-53,45**	**13,46**	**-3,97**	**<.001**	**,001**
Africa - South-East Asia	-25,9	18,29	-1,42	,157	1
Americas - Western Pacific	-11,89	13,99	-0,85	,395	1
Americas - South-East Asia	15,66	18,68	0,84	,402	1
Western Pacific - South-East Asia	27,55	19,74	1,4	,163	1

Adj. p: Values adjusted with Bonferroni correction.

Geographic analysis for HS

	Test Statistic	Std. Error	Std. Test Statistic	*p*	Adj. *p*
Eastern Mediterranean - Europe	**-63,41**	**13,83**	**-4,59**	**<,001**	**<,001**
Eastern Mediterranean - Africa	18,37	14,1	1,3	,193	1
Eastern Mediterranean - Americas	-14,33	14,61	-0,98	,326	1
Eastern Mediterranean - Western Pacific	-0,48	15,93	-0,03	,976	1
Eastern Mediterranean - South-East Asia	-17,17	20,18	-0,85	,395	1
Europe - Africa	**81,78**	**10,89**	**7,51**	**<,001**	**<,001**
Europe - Americas	**49,08**	**11,53**	**4,26**	**<,001**	**<,001**
Europe - Western Pacific	**62,93**	**13,17**	**4,78**	**<,001**	**<,001**
Europe - South-East Asia	46,23	18,08	2,56	,011	,158
Africa - Americas	-32,7	11,86	-2,76	,006	,087
Africa - Western Pacific	-18,85	13,46	-1,4	,161	1
Africa - South-East Asia	-35,55	18,29	-1,94	,052	,78
Americas - Western Pacific	13,85	13,99	0,99	,322	1
Americas - South-East Asia	-2,84	18,68	-0,15	,879	1
Western Pacific - South-East Asia	-16,7	19,74	-0,85	,398	1

Adj. p: Values adjusted with Bonferroni correction.

Geographic analysis for CN

	Test Statistic	Std. Error	Std. Test Statistic	*p*	Adj. *p*
Eastern Mediterranean - Europe	**-80,18**	**13,82**	**-5,8**	**<,001**	**<,001**
Eastern Mediterranean - Africa	-33,01	14,1	-2,34	,019	,289
Eastern Mediterranean - Americas	-44,1	14,6	-3,02	,003	,038
Eastern Mediterranean - Western Pacific	-33,76	15,93	-2,12	,034	,511
Eastern Mediterranean - South-East Asia	-36,47	20,18	-1,81	,071	1
Europe - Africa	**47,17**	**10,89**	**4,33**	**<,001**	**<,001**
Europe - Americas	36,08	11,53	3,13	,002	,026
Europe - Western Pacific	46,42	13,17	3,53	<.001	,006
Europe - South-East Asia	43,7	18,08	2,42	,016	,235
Africa - Americas	-11,09	11,86	-0,93	,35	1
Africa - Western Pacific	-0,75	13,46	-0,06	,956	1
Africa - South-East Asia	-3,47	18,29	-0,19	,85	1
Americas - Western Pacific	10,34	13,98	0,74	,46	1
Americas - South-East Asia	7,62	18,68	0,41	,683	1
Western Pacific - South-East Asia	-2,72	19,73	-0,14	,89	1

Adj. p: Values adjusted with Bonferroni correction.

Geographic analysis for RE

	Test Statistic	Std. Error	Std. Test Statistic	*p*	Adj. *p*
Eastern Mediterranean - Europe	**-71,37**	**13,83**	**-5,16**	**<,001**	**<,001**
Eastern Mediterranean - Africa	16,67	14,1	1,18	,237	1
Eastern Mediterranean - Americas	-29,07	14,61	-1,99	,047	,698
Eastern Mediterranean - Western Pacific	-43,8	15,93	-2,75	,006	,09
Eastern Mediterranean - South-East Asia	-19,85	20,18	-0,98	,325	1
Europe - Africa	**88,04**	**10,89**	**8,09**	**<,001**	**<,001**
Europe - Americas	**42,3**	**11,53**	**3,67**	**<,001**	**,004**
Europe - Western Pacific	27,57	13,17	2,09	,036	,545
Europe - South-East Asia	51,52	18,08	2,85	,004	,066
Africa - Americas	-45,74	11,86	-3,86	<.001	,002
Africa - Western Pacific	**-60,47**	**13,46**	**-4,49**	**<,001**	**<,001**
Africa - South-East Asia	-36,52	18,29	-2	,046	,689
Americas - Western Pacific	-14,73	13,99	-1,05	,292	1
Americas - South-East Asia	9,22	18,68	0,49	,622	1
Western Pacific - South-East Asia	23,95	19,74	1,21	,225	1

Adj. p: Values adjusted with Bonferroni correction.