Universal Health Coverage: A Basis for Pandemic Preparedness?

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Universal Health Coverage: A Basis for Pandemic Preparedness?

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Abstract

Amid extensive research and reporting on the effects of COVID-19 on Universal Health Coverage (UHC) progress, this study explores an often neglected topic: the potential of UHC to contribute to the foundations of pandemic preparedness. Herein, quantitative analysis reveals that countries with higher UHC coverage tend to exhibit greater pandemic preparedness (as determined by the UHC Service Coverage Index and the Global Health Security Index). Complementary qualitative analysis is used to further illustrate and explain the correlation between UHC and pandemic preparedness using four case study countries, integrating literature reviews and relevant expert interviews. Through these methods, a clear tie between high UHC status and enhanced pandemic preparedness emerges.

Finally, the study advocates for UHC as an enhancer of global health security in the face of emerging infectious disease threats and a cornerstone of pandemic preparedness. This further suggests avenues for further research to explore additional indicators and determinants that influence UHC, pandemic preparedness, and their intersections. These insights are especially relevant at a time when international organizations such as the WHO deliberate on pandemic preparedness policies, which may benefit from the global advancement of UHC.
Acknowledgements

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Also with deep gratitude to the interviewees who helped to shape this study and supplied invaluable information and advice, including Dr. Houcine Akhnif, Dr. Tara Kirk Sell, and Dr. Gustavo Hernandez.

Finally, I would like to thank my host Swiss host mother and the other program participants who have brought me intellectual conversations and more than a fair amount of joy this semester. Thank you for making me feel welcome, providing me with interesting thoughts and ideas, and keeping up a positive atmosphere for the duration of this project.
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Introduction

In 2023, the World Health Organization (WHO) celebrated its 75th birthday with the World Health Day theme of “Health for All.” As one of the most prominent international health organizations, the WHO’s focus on Universal Health Care, or UHC, has led it to be a topic of conversation and development work across the globe. In fact, UHC has been a major goal for the WHO for several decades, especially articulated in the Sustainable Development Goals (SDGs) 3.8: “Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all” (WHO, 2023). The latter part of this SDG gained heightened recognition in the face of the COVID-19 pandemic when nations clamored for SARS-CoV-2 vaccines to protect their populations. The distribution of vaccines in a timely, efficient, and equitable manner proved to be a challenge for nations in both an internal and international sense.

The challenges that arose during this period of time had, and continue to have, dynamic interactions with the statute and implementation of UHC. In most nations, the COVID-19 pandemic had negative effects on the progression of UHC, yet, as will be seen in later sections, there have been positive policy outcomes and system learning that have arisen since the start of the pandemic. In essence, the effects of COVID-19 on UHC have been varied and often appear as a mixture of regressions and progressions that can prove difficult to track. However, one result has been unequivocal: the COVID-19 pandemic unmasked glaring gaps and vulnerabilities in the ability of healthcare systems, national governments, and the international community to react to fast-spreading emerging infectious disease outbreaks.

The aim of this research is to examine UHC in another aspect— not just as a sector impacted by the COVID-19 pandemic, but to explore it as a potential tool for building a
foundation of increased preparedness when the next pandemic strikes. This research ultimately brings together two major goals of the WHO today, the aforementioned fight for UHC and the ongoing efforts of the Intergovernmental Negotiating Body on the Pandemic Preparedness and Response Accords. With a recognition that the likelihood of future pandemics is only likely to increase in the coming years with the threats from climate change and human encroachment into natural environments, these topics should be approached with a sense of sincerity and urgency. Increasingly, there will be a need to find real and tangible solutions and elements that bolster the ability of nations and the international community to be prepared for and respond to these types of events. This, coupled with the already known benefits of the introduction of UHC for other aspects of healthcare and the overall well being of populations, makes universal health coverage an intriguing avenue of exploration. Thus, the research presented in this paper aims to address the following question: Is Universal Health Coverage a viable foundation for enhancing pandemic preparedness?

In order to achieve a comprehensive analysis of this question, this paper will utilize both quantitative and qualitative methods, the former in the form of health indicators and the latter in the form of literature reviews. These will be used to illustrate both broad trends and specific cases; three countries’ UHC systems will be explained in relation to pandemic preparation aspects, touching on the changes from the time prior to the COVID-19 pandemic. Finally, the research focus will broaden to explore how UHC implementation may contribute to the coordination of international-scale pandemic preparedness. In so doing, this research will add dimension to important ongoing discussions about the roles of UHC and pandemic preparation and response by relating the two in a novel manner: UHC as an underpinning of future pandemic preparation.
Research Methodology

This study employs a mixed-methods approach, applying both quantitative and qualitative data to provide a deeper and more comprehensive understanding of the relationships between universal health coverage (UHC) and pandemic preparedness. These methods are applied through three major methodologies: quantitative analysis of indicators of pandemic preparedness and UHC, literature reviews on relevant topics, and the integration of primary information in the form of interviews.

For the purposes and scope of this study, it was most efficient to choose one specific indicator for universal health coverage and for pandemic preparedness each. The criteria for choosing these indicators was that they be an internationally agreed-upon source of reputable information, that they contain at least 190 countries of analysis, that the data is publicly accessible, and that the components of the indicators were explicitly stated and preferably explained in detail. Ultimately, the choice was made to utilize the UHC Service Coverage Index (UHC SCI) for the UHC indicator as it met all the previous qualifications and is provided by the WHO explicitly to act as one of the indicators relied upon to measure the progress of the sustainable development goals. The most recent available data (2021) was used for this analysis in order to ensure the most relevant results.

The indicator of choice for pandemic preparedness is Indicator 3.1 of the large dataset provided in the Global Health Security Index, a condition-fulfilling index that was updated in 2021 and is a collaborative partnership between the Johns Hopkins Center for Health Security and the Nuclear Threat Initiative. The indicator of use falls under the “Rapid response to and mitigation of the spread of an epidemic” category and is entitled “Emergency preparedness and response planning.” This indicator was chosen specifically due to the focus it has on
preparedness bases for the final score (more information on specific included information may be found in Table 1). However, the selection of this category proves to be a limitation on the analysis; expanding to include other preparedness-relevant indicators, such as immunization, real-time surveillance, epidemiology workforce, etc. would have enhanced the analysis. Data from these two indicators were collated to one database, cross-referencing for differences between countries included in analysis (a total of 193 countries). Regression analysis was completed and graphs created with R Studio to examine the correlative status of pandemic preparedness in relation to UHC status by country.

Data for regression analysis to assess wealth as a potential confounder to this relationship was pulled from the United Nations’ Department of Economics and Social Affairs country-by-country gross domestic product (GDP) per capita in US dollars. GDP per capita has been a tool for measuring a nation's wealth for decades and has previously been shown to be an adequate measure of wealth for comparison between nations (Mumford, 2016). However, there are several other potential confounding variables that could have been overlooked that would further complicate the relationships shown in the analyses and may significantly impact pandemic preparedness beyond wealth alone.

Literature reviews for this paper were broken into several categories to align with the goals of the research. For an overarching view on the topic, a literature review was conducted to identify major themes among the literature about the potential advantages to seeing UHC as a basis for pandemic preparedness and potential challenges with implementation within countries and for the global community. While the literature on this topic is limited, there have been several recently-written policy briefs and reports that were incorporated to provide a background discussion of current topics in the field.
Further literature review was conducted to provide insight into controversies with indicators of pandemic preparedness and to justify the use of the GHSI as the unit of analysis in this research. Additionally, short reviews were conducted for each of the countries included in case studies to address commonly-discussed themes and potential areas of analysis. Materials for review were found through searches of relevant scientific literature, or in the case of the Morocco study, were recommended by the interviewee. Finally, literature searches provided a background of current thought in the potential opportunities or imperatives for UHC in a global health security context.

Finally, interviews were conducted in order to provide a more in-depth, detailed account on specific areas of the project from relevant professionals in the field. Informed consent was obtained from the interviewees to ensure they understood the purpose of the study and oral consent for the use of the interviewees’ names and other identifying information was obtained. Interviews were not recorded, but extensive notes were taken, including quotes from interviewees. The interview with Dr. Tara Sell provided the background necessary to understand the usage and evaluation of GHSI indicators, as well as providing generous insight into the usage and relevance of UHC in a global context, especially in the sector of health security. Though the interview could not be conducted in person due to distance constraints, Dr. Sell’s role as a researcher within the Johns Hopkins Center for Health Security meant that she is especially qualified to speak to these particular aspects of the GHSI and the changing landscape of global health security. Dr. Gustavo Hernandez provided an inside look at the Swiss healthcare system in terms of UHC, COVID-19 and pandemic preparedness in an informal interview. A formal interview was also held with Dr. Houcine Akhnif, a health officer of the WHO based in Morocco with a background in health financing, health systems learning, and policy dialogue. His lent
depth to the analysis of Moroccan progress in UHC, how the country handled the COVID-19 pandemic, and the unique aspects of the healthcare system that may help to prepare for and respond to future disease outbreaks and pandemics.

Literature Review

The intersections of UHC and pandemic preparedness was a subject of discussion even before the COVID-19 pandemic broke over the world. As early as the mid 2010s, articles detailing how UHC could large-scale outbreaks began to appear. One such 2014 article from The Union entitled “Universal Health Coverage Could Prevent Disease Outbreaks from Being Crises” came only two days before the first Universal Health Coverage Day. Taking the example of the Ebola outbreaks of the time, the authors argued that a major breaking point stopping the spread of disease was the lack of capability and capacity of local and regional healthcare systems to provide people with basic-level care. Because of this, there is “no umbrella of infection control in the general health services,” which ultimately leads to the outcome of patient-to-patient and even patient-to-physician spread (The Union, 2014). The journal presents UHC as a viable option to combat this issue, but offers little evidence or proposals on policy implementation.

However, as time went on and the threat of a global pandemic became all too real, the abstract idea of UHC as pandemic preparedness became more developed and enriched. In October of 2020, the United Nations released a policy brief entitled “COVID-19 and Universal Health Coverage” which detailed the major challenges and opportunities in stopping the current pandemic and preparing for the next. Out of the recommended actions put forth in this document, the final focuses on creating healthier societies that are better prepared for pandemics to come. The policy brief specifically mentions “tools for emergency response planning to coordination
and financing, risk communications and community engagement, health surveillance, infection prevention and control and laboratory testing” as specific areas which are essential to pandemic preparedness and which require a strong healthcare system basis (United Nations, 2020). All categories would be well served by focusing on increasing the foundations of UHC, and the authors recommend that countries and health-focused donors make it a priority in policy and in general action.

Additionally, pieces like that which is published by Nesson (2021) expound on the importance of a universalized healthcare system that is “equitable, resilient, and capable of meeting everyone’s needs.” The author explains that the advantages of UHC lie in its commitment to protecting the health of everyone, regardless of who they are or their wealth status. As disease does not discriminate between in regards to infection, the healthcare system should not either; the best way to stop the spread of disease to anyone is to stop the spread of the disease for everyone. Vaccinating only certain sectors of the population does not provide the herd immunity needed to stop a rapidly mutating virus if it is left unchecked in other sectors, and only providing preventative medicine and care to those who can afford it results in huge stain on hospital systems and providers when in the throes of an outbreak.

This is a sentiment echoed by Bejar and Luchesi (2023) who state that “health systems are better equipped to identify and address health threats early, provide timely treatment to those affected, and prevent the spread of diseases, thereby strengthening the health resilience of people and their communities” when there is access to quality primary health care services. They frame capacity building and health systems resilience as a major goal of UHC and also one of the most fundamental and impactful forms of pandemic preparedness. This includes categories across the healthcare pipeline including data systems and data management, outbreak prediction, supply
chains for vaccines, treatments, infrastructure, and community/practitioner engagement.

Importantly, these authors note that all of these elements are not only useful in the face of pandemics, but also are beneficial for the overall strength and efficiency of health systems in times of non-crisis. The stronger they can be made in times of low system-strain, the more elastic and reactive they will be when the situation becomes urgent. Finally, the authors place special emphasis on the importance of routine immunizations, a topic this paper will return to in the discussion of pandemic preparedness indexes and indicators.

Analysis

UHC and Pandemic Preparedness

Health indicators are a constant necessity in order for local, state, and global governance to measure current standards, identify gaps, and move to make improvements. While some indicators remain in use over time, new indicators are frequently added for depth of understanding and nuance in progressive approaches. However, identifying how to capture and display indicators for health data — especially when it comes to policy and other complex, uncertain variables— can be difficult. Many critics of health indicators frequently cite this difficulty as a problem; as Kentikelenis and Seabrooke (2022) note, “indicators may be neglecting what is important for what is easily accessible.”

In a conversation with Dr. Tara Kirk Sell, a research scientist at the Johns Hopkins Center for Health Security (JHCHS), she reiterated the idea that it can be very difficult to obtain indicators that predict health security. The JHCHS is the main driving force behind the Global Health Security Index, or GHSI. The GHSI was created in 2019 to address concerns surrounding global health security as under threat from bioweapons and other man-made biological threats,
the GHSI is not without its pitfalls (Kentikelenis & Seabrooke, 2021). While it provides a very transparent accounting of scores across health security categories (including pandemic preparedness and response), it has been criticized for its private approach—governments are not allowed to advocate for or refute scores within the system, leading to potentially negative funding outcomes from organizations like the World Bank (Kentikelenis & Seabrooke, 2022).

However, the GHSI is still highly regarded as a pandemic preparedness indicator index system, and has undergone updates over the past several years to better capture further emerging influences in pandemic preparation and response capacities, especially those in the more social sectors (Ravi et al., 2020 and Mahajan, 2021). Dr. Sell explained that the COVID-19 pandemic brought to light the importance of social factors in pandemic preparedness and response: “Basic community functioning and government trust are strong indicators of how well a country will do in a pandemic…we could create an amazing countermeasure super fast that works incredibly well to prevent disease and infection, but if people don’t trust it, don’t trust what authorities are asking them to do, then it’s not worth much” (Sell, T.K., personal communication, October 20, 2020). Bollky et al. (2022) published findings suggesting that “measures of trust in the government and interpersonal trust, as well as less government corruption, had larger, statistically significant associations with lower standardized infection rates” during the COVID-19 pandemic. It is therefore relevant to this analysis to use the GHSI as an indicator of pandemic preparedness due to its consideration of these types of aspects of social factors of disease. It also raises the interesting question of potential associations between UHC and public trust in government and public health officials, though this is beyond the scope of this study.

In addition to public trust, Dr. Sell cited staffing, funding, and training as a basic competence of medical and public health systems that must be met in order to build effective
preparation strategies. These thoughts echo those of proponents of UHC, calling to mind the SDGs and the objectives outlined by the WHO to create system efficiency in health facilities and healthcare financing. The bases for health system components of UHC rely heavily on health facilities and health financing, service delivery, and communications networks, which is termed health resourcing. As Cerf (2023) states, “sufficient health resourcing is required for equipping and preparing health systems, i.e., gearing health systems.” The interplay between this school of thought and Dr. Sell’s research lends credit to the conception that the components that underlie a competent UHC system may serve as the same for pandemic preparedness—at least in qualitative terms.

However, in order to make more certain assertions, this investigation benefits from expansion to include a quantitative analysis of health predictor indicators. As further described in the methods section of this paper, the search for association between UHC status and pandemic preparedness of countries was performed utilizing the GHSI for the independent variables of exploration. Figure 1 shows the overall GHSI index score of 193 countries as a function of the UHC score as determined by UHC Service Coverage Index (UHC SCI). The overall GHSI index score contains six major categories (prevention, detection and reporting, rapid response, health system, compliance with international norms, and risk environment) that rely on 37 indicators made up of 96 separate subindicators (GHS Index Methodology, 2021). While a complex index framework, the inclusion of many indicators aims to provide a more balanced and verifiable outlook for each country analyzed, especially when weighted and normalized.

From Figure 1, there is a clear association (SLR, p<0.001) between a high UHC SCI score and high GHSI overall score; in essence, the higher the level of UHC in a country, the
greater the overall health security of the nation, at least according to the GHSI. This of course, does not mean that the health security of a nation is perfect—far from it. As will be explored in the later case studies regarding the United States, Switzerland, Morocco, and Thailand, GHSI does not perfectly predict how a country performed during COVID, nor should it be taken as an absolute measure of health security in the face of future disease threats.

Furthermore, overall country wealth often determines the amount of money put forward to healthcare expenditure in general (including public health expenditures), the amount of wealth available in both public and private healthcare systems, and the availability of the private sector to support the public sector in the face of crises in general (Bollyky et al., 2022). The results of Figure 2 showcase that it is not only UHC that can be seen to have a significant positive correlation with GHSI, but also country wealth as determined by GDP per capita (p<0.001).

While analysis was not performed to determine whether the wealth status of a nation was a true
confounder for this or the subsequent analyses, it should be kept in mind as an element that holds significant weight in the provisioning of GHSI across countries. However, as will be discussed in the case study analyses, some countries which have low GDP per capita still score well in terms of the GHSI due to the structuring of their healthcare systems.

While the overall score for GHSI provides an overview of health security and UHC, for the purposes of a succinct analysis, it became clear that it would be beneficial to narrow the scope to one specific indicator which could then be explored more fully. The sector chosen (from many which should be considered viable) was 3.1: Emergency preparedness and response planning. This choice of indicator was made because it pulls together many of the other, previous indicators into an integrated plan that covers multiple aspects of preparedness. As stated by Kachali et al. (2022) “preparedness involves planning for and developing response capabilities,” and thus an indicator revolving around response plans can be seen as a representative of pandemic preparedness as a whole. Indicator 3.1 contains three subindicators, based upon six...
questions regarding national public health emergency response plans, their allowances for underserved/vulnerable populations, and non-pharmaceutical intervention planning (GHS Index Methodology, 2021). Table 1 illustrates these subindicators and associated questions in greater detail.

In Figure 3, GHSI Indicator 3.1 is viewed on its own as a pandemic preparedness indicator. Here, a similar trend to the one seen previously emerges: the higher the UHC SCI, the greater the GHSI 3.1 score (SLR, p<0.001). However, several notable shifts have occurred. Firstly, there has been some graph location movement of the countries of analysis, which can be exemplified through the case study countries, where the United States falls significantly while Switzerland and Thailand rise to the top of the GHSI axis. Secondly, there appears to be a wider spread across the plot when countries are analyzed just from the score of Indicator 3.1 and not as an overall GHSI score. There may be several reasons for this, including the lack of available data for this single indicator due to poor reporting through the WHO’s Joint External Evaluation (JEE), a self-report assessment for countries to assess preparedness to general public health risks.

If a country does not report for a category, results to the questions in Table 1 will invariably be

<table>
<thead>
<tr>
<th>Table 1. Adapted from the 2021 GHS Index Methodology as prepared by Economist Impact. Table shows the subindicators and questions associated with indicator 3.1 Emergency Preparedness and Response Planning.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.1 Emergency preparedness and response planning</strong></td>
</tr>
<tr>
<td><strong>3.1.1 National public health emergency preparedness and response plan</strong></td>
</tr>
<tr>
<td>3.1.a Completed JEE assessments; Economist Impact analyst qualitative assessment based on official national sources, which vary by country</td>
</tr>
<tr>
<td>Does the country have an overarching national public health emergency response plan in place which addresses planning for multiple communicable diseases with epidemic or pandemic potential?</td>
</tr>
<tr>
<td>Evidence that there is a plan in place, and the plan is publicly available = 2</td>
</tr>
<tr>
<td>Evidence that the plan is in place, but the plan is not publicly available = 1</td>
</tr>
<tr>
<td>No evidence that such a plan or plans are in place = 0</td>
</tr>
<tr>
<td>3.1.b Completed JEE assessments; Economist Impact analyst qualitative assessment based on official national sources, which vary by country</td>
</tr>
<tr>
<td>If an overarching plan is in place, has it been updated in the past three years?</td>
</tr>
<tr>
<td>Yes = 1</td>
</tr>
<tr>
<td>No/no plan in place = 0</td>
</tr>
<tr>
<td>3.1.c Completed JEE assessments; Economist Impact analyst qualitative assessment based on official national sources, which vary by country</td>
</tr>
<tr>
<td>If an overarching plan is in place, does it include considerations for pediatric and/ or other vulnerable populations?</td>
</tr>
<tr>
<td>Yes = 1</td>
</tr>
<tr>
<td>No/no plan in place = 0</td>
</tr>
<tr>
<td>3.1.d WHO Strategic Partnership for IHR and Health Security (SPH)</td>
</tr>
<tr>
<td>Does the country have a publicly available plan in place specifically for pandemic influenza preparedness that has been updated since 2009?</td>
</tr>
<tr>
<td>Yes = 1</td>
</tr>
<tr>
<td>No = 0</td>
</tr>
<tr>
<td><strong>3.1.2 Private sector involvement in response planning</strong></td>
</tr>
<tr>
<td>3.1.2a Completed JEE assessments; Economist Impact analyst qualitative assessment based on official national sources, which vary by country</td>
</tr>
<tr>
<td>Does the country have a specific mechanism(s) for engaging with the private sector to assist with outbreak emergency preparedness and response?</td>
</tr>
<tr>
<td>Yes = 1</td>
</tr>
<tr>
<td>No = 0</td>
</tr>
<tr>
<td><strong>3.3 Non-pharmaceutical interventions planning</strong></td>
</tr>
<tr>
<td>3.3.1a Economist Impact analyst qualitative assessment based on official national sources, which vary by country</td>
</tr>
<tr>
<td>Does the country have a policy, plan, and/ or guidelines in place to implement non-pharmaceutical interventions (NPIs) during an epidemic or pandemic?</td>
</tr>
<tr>
<td>Yes, a policy, plan, and/or guidelines are in place for more than one disease = 2</td>
</tr>
<tr>
<td>Yes, but the policy, plan, and/or guidelines exist only for one disease = 1</td>
</tr>
<tr>
<td>No = 0</td>
</tr>
</tbody>
</table>
biased, leading to skewed data. Alternatively, this particular indicator may have specific links to universal health coverage, which makes it an interesting subindicator to focus on in the following case studies.

Figure 3. Global Health Security Index subindicator 3.1 Pandemic Preparedness and Response Planning scores for 193 countries as a function of the level of Universal Health Coverage as determined by the UHC Service Coverage Index. Positive association was confirmed by a simple linear regression test ($p < 0.001$, adjusted $R$-squared value: 0.2388). Case study countries (United States, Switzerland, Morocco, and Thailand) are highlighted in color for ease of locating.
Case Studies

Switzerland

The Swiss healthcare system follows a Bismarkian model of universal healthcare; it has a decentralized healthcare system in which all residents are required by law to have health insurance coverage, but it is not administered by a single-payer system. Instead, health insurance purchases are made in private markets that allow for patient choice and competition amongst both insurers and healthcare providers. While most patients pay a premium, the state covers the health insurance costs for the poorest percentage of the population, allowing all equal access to care. These aspects of the Swiss healthcare system lead it to be highly-regarded globally as the care is of high quality, efficient, and often scores highly in patient satisfaction.

However, due to the nature of governance in Switzerland, cantons maintain a significant amount of autonomy over the organization of healthcare in regions. This can result in variations in care and premium prices across the country, which can leave poor regions at an economic disadvantage when attempting to buy insurance and utilize healthcare services. During the COVID-19 pandemic, the Swiss healthcare system felt the strain of disease burden like other nations around the globe. This was made even more difficult by the high amount of cantonal decision making power that outweighed the decisions of the federal government. In the first few months of the pandemic, this led to such an uncoordinated response and high morbidity/mortality that the Swiss federal government made an extraordinary exception: “not only did the federal government introduce country-wide measures, in its strict definition of the law it also prohibited most deviations (also if they were stricter) by the cantons” (Schnabel & Hegele, 2021). While this type of national-scale decision making was revoked after only a few months, it serves to
highlight fragmentation with the Swiss governance system which extends to the healthcare system when it comes to pandemic preparedness and response.

The aforementioned topics are exemplified in Figures 1 and 3, where Switzerland has both an excellent UHC SCI score and pandemic indicator scores. In fact, for Indicator 3.1, Switzerland scored the highest of all 193 countries in the GHSI analysis, only slightly edging out Thailand. It appears far above the regression lines for both figures, illustrating the potential strength of the Swiss healthcare system when it comes to future health crises brought about by infectious disease. These results can be attributed to the existence of a robust UHC system in Switzerland which allows equal access to care regardless of place and other socioeconomic factors. Thus, this analysis shows how UHC underlies a pandemic preparedness and response, even in a country with decentralized governance.

Looking to the future, there are multiple avenues that Switzerland could consider to reduce the lag time in creating national guidance and synchronous policy rollout that occurred during the COVID-19 pandemic. Firstly, Switzerland’s reliance on private insurers and hospitals contributes to general decentralization of healthcare in the nation as it is independent of the federal government and can act on its own rules basis, even in crisis scenarios. To combat this, future policy that seeks to align the private sector with governmental action and policy will likely aid in better pandemic preparedness and health security for Swiss residents. However, the most important aspect to consider in future policy will be the existence of national plans for outbreak response.

As it stands, the Swiss government can act as a whole in extreme circumstances, but the definition of “extreme” is still up for contestation. Creating more tangible and actional pandemic preparedness regulations and plans of actions that involve the nation as a whole, while also
taking into account the needs of individual cantons. As Burger et al. (2022) state, “rather than being limited to one approach, a future strategic recommendation for a Swiss emergency response mechanism is to integrate elements of both [national and cantonal] approaches.” Dr. Gustavo Hernandez, a Swiss physician, agrees that this approach allows for the tailoring of services to fit specific populations while still ensuring timely, appropriate, and effective responses. This sort of bottom-up approach, he explained, is built on the cantonal-level needs of populations and allows adjustment and specificity in crisis scenarios (Hernandez, personal communication, November 28, 2023). In this way, the Swiss UHC system will have the best chance of functioning at its highest ability in aiding healthcare capacity and pandemic preparedness strategies.

Morocco

Prior to the implementation of recent UHC initiatives, Morocco faced many challenges in the healthcare sector, especially in healthcare services delivery. Healthcare access has historically been highly limited, especially for those who live in rural areas and those in the poorest sector of the population. The result of this were significant financial burdens for those who required medical services, whether routine or otherwise. However, in more recent years, the Moroccan government has made it a priority to invest in healthcare systems and to implement UHC initiatives (Tinasti, 2015).

In 2012, the Medical Assistance Regime (RAMED) was introduced, which aims to serve the most economically-disadvantaged groups of the population by providing them with free or significantly less expensive healthcare. Today, this program serves more than 8 million Moroccans, some of whom pay a state-subsidized premium. However, the private insurance market still exists in Morocco, mostly associated with employers. Between these two insurance
schemes, only 64% of Moroccans have healthcare coverage (Akhnif, 2023). The remainder of the population are considered independants and most are employed in the informal sector of the economy. Clearly, while RAMED has shown to be beneficial to increasing healthcare accessibility, large sections of the population remain vulnerable.

In conjunction with and to help guide the continued expansion of RAMED, Morocco has created the High Authority of Health, an office which serves to “guide future policies through policy analysis and evaluations, studies, and guidelines, implement regulations for more efficiency in using the health system resources, conduct strategic studies to enhance the action on the ground, develop capacities at all levels of the health system, and ensure the continuity of health policies” (Akhnif, 2023). The overall intent of this office is to create a more synchronized approach to the implementation of UHC initiatives nationally, as well as to bring a more equitable approach to Moroccan healthcare in general. As a result, during the COVID-19 pandemic, the Moroccan mobilization of healthcare services was likely more streamlined than it would have been otherwise, and this had measurable effects on pandemic response in the country.

In conversation with Dr. Houssain Akhnif, a WHO healthcare financing specialist in Morocco, he mentioned how the existence of the higher health financing and coordination offices aided in responses during the pandemic and informed future preparation strategies. He explained, “The Ministry of Interior, the military, all the government entities were involved in the response, and that was really the specificity of the country that was really interesting in terms of operationalizing the multisectorial reality at different levels of the health system” (Akhnif, H., personal communication, November 3, 2023). He specifically cites the ability of these agencies to direct funding to the necessary places, especially in emergency scenarios. “Without the money
invested in hospitals and insurance,” he stated, “we cannot say that the response would have been good.” Even prior to the COVID-19 pandemic the idea of national health oversight and the ability of these kinds of organizations to use system learning to drive UHC progress was seen as an “opportunity to push forward a more structural transformation towards a learning system” (Akhnif et al., 2019).

In Figures 1 and 3, we can see that Morocco still falls below the regression lines, likely due to combination of factors including a lack of financial ability to finance their healthcare systems, global inequities (e.g. PPE and vaccine access), and the low percentage of the population covered by health insurance. While RAMED may be expanding access to more people than previously covered, Morocco falls significantly short of the other countries of analysis on the UHC SCI axis. For both the overall GHSI and Indicator 3.1, the explanation of a lower level of UHC may help to explain the results seen. Overall, given the categories that the GHSI places emphasis on, countries like Morocco without established healthcare systems that run efficiently and care for the majority of the population will be at a disadvantage compared to wealthier countries with more ability to provide preparation infrastructure and equitable care. Particularly for Indicator 3.1, which relies on the ability of the nation to create emergency response plans, Morocco may be at a disadvantage due to finances and the relative newness of its High Authority of Health and other more nationally-focused governmental health agencies.

While the results here may seem disheartening, Morocco’s progress towards UHC has been positive and steadily building. Perhaps most importantly, it has the support of the public both in thought and in practice. During the COVID-19 pandemic, the previously mentioned mass-vaccination campaign was financed by the public through freely-given donations. Dr. Akhnif explained that this type of social solidarity as a form of crisis preparedness and response is
highly relevant in lower-income nations that may have less governmental ability to procure funds for necessary activities in a timely manner. In Morocco, he says, “there was a solidarity fund that was used to purchase vaccines for the whole population…and this can also be included as another type of Universal Health Coverage. It’s a contributory fund…a government program that was created in response to the pandemic.” The King of Morocco makes the first contribution, and then the public follows suit, making donations to the fund that then are spent, usually to cover the needs of the poorest part of the population. He explained how this idea was then utilized again during the 2023 Moroccan earthquake. Money already existed in an emergency fund to which citizens could then contribute further, providing funds for disaster relief: “Instead of those bureaucratic funds that wait for the contributions coming officially from everywhere [outside of Morocco], and having to decide how to divide and allocate this…there is something to quickly implement and quickly respond. Those solidarity funds are more flexible than money coming from taxes and the government” (Akhnif, H., personal communication, November 3, 2023). Due to this, while beyond the scope of this research, this type of health emergency financing is successful and should be considered an integral part of future pandemic planning and preparedness.

The United States of America

The United States of America’s healthcare system has been termed the “American Model” for its non-adherence to many aspects of other internationally-recognized models such as Bismarck or Beverdige. Unlike these other two widely-adopted systems, it does not provide universal health coverage, but rather employs a mix of public and private sector insurance and hospitals to provide care to the population. While the government covers the population over the age of 65 and those who are in the lowest income percentage, the remainder of people are left to
fend for themselves in the insurance markets. While much of U.S. private insurance is provided by employers to employees, individual purchasing markets through state exchanges are common as well. However, as no universal mandate exists to require coverage or punish those who do not purchase it, there is a high level of un/underinsurance as people choose or are forced because of monetary or pre-existing conditions to remain uninsured.

While high amounts of technological innovation and research abound in the American System, systemic challenges remain. Its mixed, multifaceted system leads to intense fragmentation of the U.S. healthcare system, undermining efforts to create any form of national healthcare baseline. Amount, accessibility, and quality of care varies widely, creating disparities between regions, wealth statuses, race, and other social categories. As stated previously, infectious disease does not itself discriminate, and thus the lack of universal healthcare may be associated with disastrous consequences for individual and population-level health. When great portions of the population are unable to access essential healthcare services, especially in times of crisis, more than just the uninsured suffer as the system balks under the strain and disease spread increases.

During and after the COVID-19 pandemic, multiple studies have lamented just this fact. Utilizing mortality models, studies found that a single-payer system (such as the Beveridge model) would have saved over 212,000 in 2020 and 335,000 lives total in the U.S (Galvani et al., 2022 and Nuwer, 2022). Additionally, the studies say that hundreds of billions of dollars could have been saved during COVID-19 with a universal healthcare system. As one cites, the usage of employer-sponsored insurance was specifically disastrous for the United States: “Business closures and restrictions led to unemployment for more than 9 million individuals following the
emergence of COVID-19. Consequently, many Americans lost their healthcare precisely at a time when COVID-19 sharply heightened the need for medical services” (Galvani et al., 2022).

This particular information seems quite at odds with the results generated in Figures 1 and 3, where UHC SCI is remarkably high, putting the U.S. much farther along the x-axis than other countries, such as South Korea, which do have full UHC systems. Thus, the question arises: how can the U.S., which is famous for its lack of UHC, have such a high UHC SCI score? The answer comes from the way that the UHC SCI is calculated. According to the WHO, the UHC SCI is calculated by identifying indicators of essential categories: “reproductive, maternal, newborn and child health, infectious diseases, noncommunicable diseases, and service capacity and access” (WHO, 2023). By giving these indicators scores between 0 and 100, the index can determine the average coverage of these services within a nation. However, a problem with this way of indexing arises with the U.S. As previously discussed, health coverage in the United States is highly variable and inequitable; the highest level of care, when taken as an average, can outcompete the lowest levels of care, effectively hiding them in the average. This causes an inflation of the UHC SCI for the United States.

Interestingly, a similar phenomenon can be observed with the Pandemic Preparedness indicators, where the United States once again appears high on the relevant axis. However, as general knowledge, the preparedness and subsequent response to the COVID-19 by the United States was far from exemplary. This finding of high GHSI scores was, in fact, so idiosyncratic that the GHSI team published an article about the score entitled “The U.S. and COVID-19: Leading the World by GHS Index Score, Not by Response.” In this concession piece, the authors state that they felt the need to “dispel misconceptions regarding the score…received by the United States” (Isaac, 2020). By breaking down the U.S. score, they demonstrate that while the
U.S. scores remarkably well in categories such as lab systems, surveillance, and epidemiology workforces, it received scores that put it in the bottom ten percent in the world for public trust (once again calling to mind Dr. Sell’s words on trust and pandemic preparedness), health system capacity and healthcare access, among others.

Likewise, in Figure 3, the United States, while still scoring highly compared to other countries, is not the frontrunner in pandemic planning. As explained by the GHSI team, due to the lack of a comprehensive national healthcare system, “local governments may take the lead in responding to public health emergencies. Deficiencies in capacities and capabilities at the local level may undermine national readiness for events” (Grant, 2021). This, in conjunction with the results of a highly fragmented pandemic response, may help to explain why the U.S. has a lower score for Indicator 3.1.

Looking to the future, many aim to address this uncoordinated response and other pitfalls of pandemic preparedness in the U.S. by increasing UHC and national health coverage plans. Bringing the main question of this research study back into focus, the case of the U.S. demonstrates that aspects of UHC can be seen as a basis of pandemic preparedness. Firstly, UHC increases the access of all individuals to quality primary health care that reduces disease comorbidities, alleviates later strain on healthcare systems, and increases access to early diagnosis and medical care. Indirectly, this also would serve to bolster the resiliency of hospital systems in pandemic-scenarios, where non-infectious disease caseloads would be smaller and healthcare space and available workers could increase. Finally, UHC in the United States could more easily facilitate the implementation of large scale health policies in the early stages of an outbreak, such as non-pharmaceutical interventions, than a highly segmented approach. In essence, “The GHS Index documented that failure to guarantee Americans’ access to medical
care would compromise its ability to rapidly treat and stop the spread from infected patients” (Grant, 2021).

**Thailand**

In Figures 1 and 3, one country particularly stands out among the high-scorers: Thailand. While it is considered a middle-income country, Thailand appears near the highest point of the y-axis for the GHSI and pandemic preparedness. Additionally, Thailand ranks highly on the UHC SCI as well. The combination of these two realities makes Thailand one of the most relevant countries of study for this analysis, and it holds crucial implications for the connection between UHC and pandemic preparedness.

Thailand’s health system underwent a major overhaul in 2001, when the slow progress towards socialized healthcare that had begun in the 1970s culminated in the implementation of a universal healthcare system called the Universal Coverage Scheme (UCS). The UCS ensures healthcare access to all citizens and is managed by the Ministry of Public Health in public and health centers and hospitals across the country. Although insurance is mandatory, it is available from both the government and from the private sector. Healthcare access, while comprehensive, is highly locally-based; individuals receive free access to services within their local health jurisdictions, but not beyond them—except in extreme circumstances. This system is largely the result of the Thai government’s concerted effort to provide more care coverage for those in the informal economy who do not receive coverage from employers (Wagstaff & Manachoyphong, 2012).

Since the advent of the UCS, Thailand has enjoyed significant drops in childhood and maternal mortality rates, infectious disease spread, and non-communicable diseases (Tangcharoensathien *et al.*, 2018). It is no wonder then that the Thai UCH SCI score is high,
comparable to or even above many high-income nations despite its comparatively low GDP per capita. Because of this, Thailand is often cited as an example of a middle-income nation which has successfully achieved UHC and should be regarded as a model for other LMICs (Low and Middle-Income Countries) to follow on the road to UHC (Hort et al., 2017). As Tangcharoensathien et al. (2019) state, “early expansion of a strong public primary health care (PHC) system in Thailand set the foundation for future scale-up of UHC.” They cite this as particularly helpful information for other LMICs, who can begin to prepare for the future of UHC by focusing on primary care access and quality. Ultimately, this focus on primary care led Thailand to enjoy a UHC SCI score commensurate with nations that have significantly higher GDP per capitas.

During the COVID-19 pandemic, Thailand put this investment in a solid foundation of primary care to good use. As Noknoy et al. (2021) discuss, Thailand effectively reorganized their primary care practices and practitioners during the pandemic in order to staff the necessary clinics and employed “a collaborative approach with both dedicated community-based centers and general practices delivering testing and now vaccination.” Importantly, the authors also note that the private sector played a major role in the response effort in Thailand, supporting the efforts of primary care clinics, testing, vaccination, and etc. As noted in Table 1, one of the questions linked to Indicator 3.1 is the existence of mechanisms to engage the private sector with the public in emergency preparation and response. The evidence of preparation for and response to the COVID-19 pandemic by the Thai primary care system lends credit to its high overall GHSI and Indicator 3.1 scores.

The Thai healthcare system can be considered as one that performed well during the COVID-19 crisis. Determining what factors may have enabled this enables learning for
development of future pandemic planning. This type of study reveals insights that point to elements of UHC as underlying components of strong pandemic preparedness. Often-mentioned aspect is the existence of a preparedness plan that is collaborative at the national level leading to a response that is highly streamlined and the ability of all Thai individuals to seek care when necessary (Tangcharoensathien, 2023). As these are some of the main objectives of UHC, the quantitative results obtained in the study analysis are demonstrating this interplay between UHC and pandemic preparedness.

Of note, multiple sources note a particular aspect of pandemic preparedness and response in Thailand that calls to mind the interview with Dr. Aknif and his words on social solidarity in Moroccan society. Tangcharoensathien et al. (2023) elaborate, “a whole-of-society approach was adopted, whereby citizens, the private sector and civil society worked together to mitigate the impact on vulnerable populations…” Noknoy et al. (2021) agree: “In Thailand, the whole society recognised the urgency for collaboration, hence contributed to preventive and control measures.” This recurring theme of social solidarity as a potential factor leading to enhanced pandemic preparedness and response, while out of scope for this study, is nonetheless intriguing. In future work, it may be of use to explore how LMICs with varying levels of social solidarity score in pandemic preparedness and response tabulations.

Global Health Security

Through the previous case studies, it has become clear that UHC can serve as a strong basis for pandemic preparedness, providing incentive for individual countries to implement UHC policies and potentially even full UHC systems. However, it isn’t just individual nations that may benefit from a shift towards higher UHC utilization, but the globe as a whole. As made plain by the COVID-19 pandemic, the world is now, more so than ever, a highly interconnected space in
which diseases can spread quickly and an outbreak in one location can become a deadly pandemic in as long as it takes for a plane to get from London to Tokyo. In the age of precarious global health security, it becomes essential for measures to be taken to ensure the most rapid, efficient, effective, and equitable response to be made to emerging infectious disease threats. If applied correctly, realizing UHC in as many nations as possible is a goal that may help to attain a safer, more prepared, and healthier world for all.

Global health security, referred to from now on as GHS, is, in essence, the idea that there are strong public health systems around the globe from the local to the international scales that can coordinate and can prevent, detect, and respond appropriately when there is an emerging infectious disease (EID) threat anywhere in the world. UHC, as a basis of increased GHS, can be thought of in three main categories of potential benefits: global health equity, financial protection, and surveillance, detection, preparation, and response capabilities. While the latter category is the most relevant to the topic at hand, all three have large amounts of crossover between them, warranting a short explanation of the first two categories.

Firstly, UHC can aid in combating the threat to GHS from global inequality. As outlined by Bambra (2022), there are four major pathways to this inequality: unequal exposure, unequal transmission, unequal susceptibility, and unequal treatment. These pathways exist not only inside of nations, but between them as well, leading to globalized inequality of EID risk and burden. Arguments can be made for UHC as a potential aiding force for all four of these categories, especially unequal susceptibility and treatment, both of which would be reduced due to the nature of universal health coverage. Secondly, financial protection afforded from UHC may help to combat “high healthcare expenditures [which] push people into poverty, further increasing their long-term risk of ill health, particularly through communicable disease…UHC protects
against economic downturn, with unemployment associated with a lower mortality in UHC countries compared with those without” (Jain & Alam, 2017). In this way, UHC can act to reduce financial burden in scenarios of disease outbreaks and associated healthcare costs, which otherwise might prove to exacerbate the underlying susceptibility of individuals, populations, and nations to combat EID.

Most relevant to this analysis, the implementation of UHC can provide benefits to pandemic preparedness on a global scale. As the “COVID-19 and Universal Health Coverage” UN policy brief (2023) states, “pandemic preparedness and response can be seen as a global public good with commensurate global and national-level investments. It requires a standardized outbreak alert system linked to concrete actions by national and local health authorities.” UHC systems, especially those which have good national oversight, will therefore be more prepared to form linkages and connections with other nations, creating collaborative networks for exchange of knowledge, surveillance, and resource-sharing. This, essentially, lays the groundwork necessary for policy formation that includes multiple nations in order to form globalized preparation and future response policies that extend beyond national borders. As Kachali et al. (2022) report: “the WHO itself advised that without regional or global leadership and collaboration on formal pandemic planning, preparedness may veer even further in different directions across the world.”

UHC as an essential aspect of prevention of EID-driven threats to GHS is a very timely idea as the WHO hones in on the Pandemic Prevention, Preparedness, and Response Accords (PPRA) which aims to “to ensure communities, governments, and all sectors of society – within countries and globally – are better prepared and protected, in order to prevent and respond to future pandemics” (WHO Q&A, 2023). Working sessions on the accords are still on-going, and
progress is quite slow. Some estimates say that a final copy of the accords may not be in existence for several years due to the delicate and complex nature of the subject and the number of potential signee nations. However, the accords still present an excellent opportunity for UHC integration.

As Dr. Richard Gregory speaks about in a video lecture from the Global Health Centre, there is a large cross-over between the goals of UHC and the goals of GHS, mainly in the focus on the strengthening of healthcare systems. He states, “even well-run disease or issue-specific programs may misalign responsibilities with each other or the rest of the healthcare system, so strengthening health systems is an efficient and cross-cutting way that includes building the capacities of policymakers and health workers to align across and integrate programs” (Gregory, 2022). Thus, the role of policy such as the PPPRA is to create incentives and opportunities for lawmakers and public officials to collaborate and streamline pandemic preparedness processes both within and between nations. Utilizing systemic approaches such as UHC as the basis for these sorts of programs can help to effectively promote the efficient use of international resources, reduce overlap, and overall provide better protection for global health and all societies.

Conclusion

This research study focused on the comprehensive exploration of the relationship between Universal Health Coverage (UHC) and pandemic preparedness in order to determine whether UHC is a viable foundation for enhancing pandemic preparedness. Using previous knowledge, expert interviews, existing healthcare data, and case studies of four nations with varied levels of UHC and pandemic response indicator scores, it detailed how UHC may
determine and potentially be employed as a strategy to aid with a nation's readiness to combat and mitigate the impact of emerging infectious diseases.

Despite some dispute over the validity of pandemic response indicators such as the Global Health Security Index (GHSI), quantitative analysis revealed a compelling correlation between high UHC Service Coverage Index (UHC SCI) scores and high pandemic preparedness indicator scores, though this is also correlated with GDP per capita. GHSI Indicator 3.1 focused specifically on emergency preparedness and response planning, leaving potential avenues of exploration for quantitative assessments into other sub-indicators and other indicator sets entirely for a more nuanced analysis.

Through the examination of case studies involving Switzerland, Morocco, the United States, and Thailand, a clear and recurring theme emerged: UHC serves as a cornerstone for effective pandemic preparedness, as evidenced by health systems data and the retrospective accounts from the COVID-19 pandemic. These case studies exemplified how the presence or absence of comprehensive UHC systems significantly influenced a country's ability to respond to health crises and highlighted the differences in how UHC can be formed to fit the needs of specific nations.

Switzerland and Thailand, both with highly-reputed but differently structured UHC systems, emerged as exemplars of pandemic preparedness. Their healthcare systems not only facilitated widespread healthcare access, but also streamlined responses by the government and during the COVID-19 pandemic, leading to the high GHSI scores seen in the research analysis. Morocco, while showcasing positive strides towards UHC implementation, faces challenges due to financial constraints and a relatively nascent healthcare infrastructure. These reflect its struggles in pandemic preparedness seen in the quantitative analysis, but also provide hope and
new and intriguing ideas (such as the social solidarity funds) for the future. The United States encounters formidable obstacles stemming from its fragmented healthcare system, even though it may not be reflected in the quantitative analysis. In reality, this fragmentation leads to disparities in pandemic response as seen in the COVID-19 pandemic, revealing the inherent weaknesses of a healthcare landscape lacking universal coverage and equitable access to healthcare services.

Expanding on these case studies, UHC has been shown to not only hold potential benefits for individual nations but also for global welfare by fostering a more connected and prepared international community. Increased utilization of UHC can reduce susceptibility to EID threats by mitigating healthcare costs, preventing economic downturns, and creating systems which can prepare and respond to EID across borders. The integration of UHC into pandemic preparedness initiatives, such as the ongoing Pandemic Prevention, Preparedness, and Response Accords, signifies a crucial step toward this type of collaborative, globally responsive approach. The intersection of the objectives of UHC and GHS underscores the need for more intentional policy emphasizing the strengthening of healthcare systems, with the ultimate goal of efficient and effective international cooperation that results in enhanced GHS.

In future studies, it would be highly beneficial to expand the list of case study countries to include LMICs with high UHC scores and also high GHSI scores, such as Ecuador, Peru, and Bulgaria. Like Thailand, these countries may help to further illustrate the direct linkages between UHC and pandemic preparedness and simultaneously serve to refute national wealth as an absolute confounder. Additionally, there were two other themes that recurred in literature reviews and interviews: public trust as an indicator of pandemic preparedness and social solidarity based systems of health coverage as a potential solution for LMICs searching for ways to increase their pandemic preparedness capacities. While both of these subjects fall out of the range of this study,
they are intrinsically tied to it, and would make for constructive areas of further study and research.

In essence, through the approaches taken in this study it became evident that supporting and promoting UHC initiatives nationally and globally is paramount for enhancing pandemic preparedness. UHC may be in danger of being overlooked as a viable way to have resilient and strong health systems capable of communication and fast action in the face of future health crises. In order to address this, policymakers at international levels should be made aware of this linkage and advocacy efforts must be made to illuminate the benefits of UHC, even in non-pandemic times. The establishment of more inclusive healthcare systems and increased focus on collaborative global health measures are achievable goals for many nations and have the potential to be indispensable mechanisms for safeguarding the health and well-being of populations across the globe.
Abbreviations list

COVID-19 - Coronavirus Disease 2019
EID - Emerging Infectious Disease
GDP - Gross Domestic Product
GHS - Global Health Security
GHSI - Global Health Security Index
JEE - Joint External Evaluation
JHCHS - Johns Hopkins Center for Health Security
LMICs - Low and Middle-Income Countries
PPPRA - Pandemic Prevention, Preparedness, and Response Accords
SDGs - Sustainable Development Goals
SLR - Simple Linear Regression
UHC - Universal Health Coverage
UHC SCI - Universal Health Coverage Service Coverage Index
WHO - World Health Organization
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Code Appendix

# Total on health security index
# create a plot of country data
totalGHSI <- plot(ContryTotal$'GHSI_Total' ~ ContryTotal$'UHC Index',
col = ifelse(ContryTotal$Country == "Morocco", "chartreuse3",
ifelse(ContryTotal$Country == "United States of America", "blue3",
ifelse(ContryTotal$Country == "Thailand", "purple",
ifelse(ContryTotal$Country == "Switzerland", "red", "black")));

ylab = "GHSI (Overall)",
xlab = "UHC (SCI)",
main = "Country-by-Country UHC and Overall GHSI")

# run a linear regression

summary(total.lm)

# add plot to line
totalw.lm <- totalGHSI + abline(total.lm, col = "black")

# add country labels

GHSI.labels <- totalGHSI + totalw.lm +
text(ContryTotal$'GHSI_Total' ~ ContryTotal$'UHC Index',
labels = ContryTotal$Country, cex = 0.45,
col = ifelse(ContryTotal$Country == "Morocco", "chartreuse3",
ifelse(ContryTotal$Country == "United States of America", "blue3",
ifelse(ContryTotal$Country == "Thailand", "purple",
ifelse(ContryTotal$Country == "Switzerland", "red", "black")));

ylab = "Pandemic Preparedness (GHSI 3.1)",
xlab = "UHC (SCI)",
main = "Country-by-Country UHC and Pandemic Preparedness")

# create a plot of country data

summary(lreg.lm)

# add plot to line

with.lm <- sans.lm + abline(lreg.lm, col = "black")

# to mess with (wow you did it! so proud)

with.labels <- sans.lm + abline(lreg.lm, col = "black") +
text(ContryTotal$'GHSI_Total' ~ ContryTotal$'UHC Index',
labels = ContryTotal$Country, cex = 0.45,
col = ifelse(ContryTotal$Country == "Morocco", "chartreuse3",
ifelse(ContryTotal$Country == "United States of America", "blue3",
ifelse(ContryTotal$Country == "Thailand", "purple",
ifelse(ContryTotal$Country == "Switzerland", "red", "black"))))
# Country wealth in as a confounder pandemic preparedness (Total GHSI) (measured in GDP per capita in $US)

```r
wealth.lm <- lm(Wealth$'GHSI_Overall' ~ Wealth$Wealth)
summary(wealth.lm)

wealth <- plot(Wealth$'GHSI_Overall' ~ Wealth$Wealth,
col = ifelse(Wealth$Country == "Morocco", "chartreuse3",
ifelse(Wealth$Country == "United States of America", "blue3",
ifelse(Wealth$Country == "Thailand", "purple",
ifelse(Wealth$Country == "Switzerland", "red3", "black"))))),
ylab = "Total GHSI", xlab = "Wealth",
main = "Wealth and Overall GHSI by Country")

wealthline.lm <- wealth + abline(wealth.lm, col = "black")

wealth.labels <- wealth + abline(wealth.lm, col = "black") +
  text(Wealth$'GHSI_Overall' ~ Wealth$Wealth,
    labels = Wealth$Country, cex = 0.45,
    col = ifelse(Wealth$Country == "Morocco", "chartreuse3",
    ifelse(Wealth$Country == "United States of America", "blue3",
    ifelse(Wealth$Country == "Thailand", "purple",
    ifelse(Wealth$Country == "Switzerland", "red3", "black"))))
```