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The COVID-19 Pandemic in Low-Income Countries with Different GHI Severities: A New Concept to Cope with COVID-19 in these Countries

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Abstract. This study focuses on low-income countries (LICs) with different GHI severities (low, moderate, and serious) with an interest in answering the following question: Are there any fundamental differences in the outcomes of countries with different GHI severities when dealing with the COVID-19 pandemic? This study considers four pandemic-related indicators, as well as three relationships among them. Statistical modeling and analysis were performed to examine the relationships between 95 LICs and four daily COVID-19 indicators. The countries were classified into three groups by GHI severity, and data were gathered from the Johns Hopkins Coronavirus Resource Center for January 2020 to August 2021 (i.e., before and after the first vaccines). The findings suggest: (i) a standardized set of interventions is unlikely to be applicable to all countries with different GHI severities; (ii) differences exist between the three groups in terms of their capacity to cope with the pandemic; and (iii) governments and policymakers in LICs should monitor and dynamically adjust their policies to accelerate their progression in strengthening their healthcare systems. This study introduces a new concept for coping with COVID-19 in LICs in a more effective way, one based on a country's position on the GHI Severity Scale.

Keywords. COVID-19 pandemic; health system; low-income countries; GHI Severity Scale

1. Introduction

Pandemics are part of the world's history, especially as they greatly impact public health, economies, and social systems, particularly in developing countries. The COVID-19 pandemic has further emphasized the great influence on economic, political, and cultural globalization and revealed stark differences between the capacity of high- and low-income countries (HICs and LICs) to deal with such an emerging health threat while also highlighting the deep political nature of the responses at the local, national, and global scale [1]. This study therefore suggests that such differences cannot be ignored when trying to deal with the COVID-19 pandemic in LICs.

In May 2021, economists at the World Bank declared that COVID-19 was actually a developing pandemic [2]. Furthermore, The Department of Economic and Social Affairs at the United Nations reported the following about COVID-19 during 2020–2021: (i) Top economists had indicated that the impacts of *COVID-19* will be severe and long lasting

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for *developing countries*, and (ii) the organization's board members agreed on the urgent need to expand access to vaccines, especially for developing countries, as a top priority for the international community [3]. Thus, governments and policymakers can play an important role in addressing this matter. This study focuses on LICs with different GHI severities (classified as low, moderate, and serious) and asks the following question**:** Are there any fundamental differences in the outcomes of countries with low, moderate, and serious GHI values when dealing with the COVID-19 pandemic? This study therefore aims to introduce a new concept that can serve policymakers and governments in helping LICs to cope with COVID-19 based on their position within the GHI severity scale.

2. Literature Review

The literature about COVID-19 covers two interesting aspects, namely researchers' interest in COVID-19 and the knowledge gap in coping with COVID-19 in LICs.

2.1. Researchers' interest in COVID-19

The COVID-19 pandemic was triggered by the SARS-CoV-2 virus, which is now widely considered to be more infectious than previous viruses over the last century [4], although its fatality rate is lower than its predecessor SARS-CoV-1, which manifested in 2002–2003.

Since the onset of the COVID- 19 pandemic, many researchers have focused on different aspects of it in various leading fields of interest. Among the published scientific literature about the COVID-19 pandemic's early phase between February 2020 and June 2020, the most common topics are healthcare responses and clinical manifestations, together with an increasing trend for research into clinical responses and protective measures [5].

Researchers, governments, and policymakers agree that the COVID-19 pandemic has challenged health systems, and it has had even more serious consequences in developing countries. This led to various studies focusing on LICs' specific problems with COVID-19, such as their weak health systems, limited economic means, and problems with export and import policies [6-8]. What is more, various researchers have pointed out that HICs prioritized protecting their citizens from this health threat and paid less attention to the plight of LICs [9]. Other studies have looked at the inequitable distribution of COVID-19 vaccines since the first vaccines became available. Indeed, HICs failed to deliver their promised vaccine donations to the COVAX worldwide initiative, with only around 10% of promised doses having been delivered [10].

2.2. The knowledge gap in LICs for coping with COVID-19

LICs can be characterized according to their position on the GHI severity scale, which can be summarized into five levels: low, moderate, serious, alarming, and extremely alarming. This implies that each country has its own nature in terms of different key social, economic, and political characteristics, which can in turn reflect on a country's performance in dealing with the COVID-19 pandemic.

This study found that researchers had thus far failed to consider how LICs with different GHI severities coped with COVID-19, as well as whether addressing the COVID-19 pandemic in LICs was simply a matter of vaccination coverage. It subsequently identified a knowledge gap for the relationship between a LIC's GHI severity level and the level of COVID-19 according to four indicators, namely confirmed cases, deaths, recovered cases, and the vaccination rate. Moreover, this study found there was a need to use such knowledge to build a new tool for improving COVID-19 solutions in LICs.

Technium Social Sciences Journal
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3. The COVID-19 Pandemic in LICs

The COVID-19 pandemic is generally considered to be a challenging public health issue. Its consequences in LICs relates to three aspects, namely the main characteristics of the COVID-19 pandemic, the public health systems in LICs, and LICs' responses to the COVID-19 pandemic.

3.1. COVID-19 pandemic's main characteristics

Several factors make COVID-19 more dangerous than other recent viral outbreaks. First, it has a diverse range of symptoms from mild to severe, mainly depending on age. COVID-19 primarily affects the respiratory system, sometimes causing pneumonia, but it has also been associated with neurological manifestations as well. Critically, anyone infected with COVID-19 could be infectious before showing any symptoms, and about half of those infected may not show any symptoms at all, making it difficult to know when to isolate. Thus, cheap, reliable rapid tests for COVID-19 infection have emerged as an important new tool in addressing the challenges of this pandemic [4, 11].

Second, the virus, like most coronaviruses, is able to mutate, and genetic recombination through transmission between animals and humans can also potentially lead to new genotypes and trigger new outbreaks [12, 13].

Third, this virus can spread from person to person through close direct or indirect contact, even before a person has symptoms. An infection usually starts in the mucous membranes of the mouth, nose, or eyes, as well as in the upper respiratory tract, typically the upper airways. Hence, travel restrictions, social distancing, self-isolation, and other precautionary and preventive measures are important in containing the spread of the disease [4].

Fourth, the public health systems in LICs are much more limited than those in HICs due to the different economic and social conditions. Developed countries (HICs) have a high level of ability to cope with this pandemic and its serious direct and indirect consequences. When it comes to LICs, however, the fight against the COVID-19 pandemic is much more serious due to its threat to a country's limited health system and the effects of economic instability. Thus, the COVID-19 pandemic highlighted three significant weaknesses of LICs: weak health systems, limited economic means, and problems with export/import policies.

3.2. LICs' weak health systems

Developing countries are characterized by weak health systems that are typically inadequate, even during normal times. Despite several pandemics over recent years, most countries remained poorly prepared for future health disasters, and when the COVID-19 pandemic arrived, it posed even more profound challenges [6].

The poor condition of healthcare systems is reflected in various surveys about the following subjects: behavior intervention plans (BIPs), *personal protective equipment (PPE)*, intensive care units (ICUs), international health regulations (IHR), and the *International Monetary Fund* (IMF) and the World Bank.

For BIPs and PPE, a recent survey dealt with the availability of four BIP and four PPE items in seven poor countries, namely Afghanistan, Bangladesh, Democratic Republic of Congo (DRC), Haiti, Nepal, Senegal, and Tanzania [7], finding that less than a third of clinics and health centers had any face masks. On average, just 2.3 of four BIP items and two of four PPE items were found in these countries. They also scored poorly for the preparedness of health workers to prevent the disease's spread.

Technium Social Sciences Journal
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In recent decades, LICs have received aid through the IMF and World Bank under certain conditions, such as enacting health reforms like imposing user fees. These reforms have had harmful implications for public health and led to worsening inequalities in access to healthcare [14-16]. Structural adjustment programs in developing countries, particularly African ones, have damaged healthcare systems, leading to them being poorly prepared to respond to the Ebola epidemic [17].

Another metric that can indicate a weak health system is a low number of ICU beds. While the US has about 33 intensive care unit (ICU) beds for every 100,000 people, in India, Pakistan, and Bangladesh it is about 2 per 100,000 people. In sub-Saharan Africa, the situation is even worse. For example, Zambia has 0.6 ICU beds per 100,000 people, while in Gambia and Uganda, it is 0.4 and 0.1, respectively [18]. In 43 of the 55 African countries, the total number of ICU beds is less than 5000, which equates to about five beds per million people, compared with about 4,000 per million people in Europe [19](15. Maclean and Marks 2020). In addition, LICs on average have 0.2 physicians and 1.0 nurses per thousand people, compared with about 8.8 nurses per thousand people in HICs [7].

3.3. The low level of economic means

LICs need to compete for goods based on their limited means, regardless of their need. This puts developing countries in a problematic position when competing to buy COVID-19-related products like vaccines and PPE. The global markets function in a way that means such products become highly concentrated in richer countries [8]. Indeed, countries like the European ones, the US, China, Japan, and Korea account for about 80% of all COVID-19 products, while their import proportion of products needed for diagnostics is even higher at close to 90%. The import proportion for PPE and hygiene products is lower at around 50–60%.

3.4. LICs' problems with export/import policies

LICs are extremely vulnerable to changes in export policies, such as export restrictions on COVID-19 tests, treatments, and PPE. Such export restrictions combined with domestic shortages pushed up global prices. The study of Espitia et al. [8] estimated that export restrictions initially increased prices of medical masks by 20.5%, venturi masks by 9.1%, and other PPE items like aprons and gloves by 1% and 2%, respectively. If major exporting countries tighten their export restrictions in response to domestic price rises, prices of COVID-19-related goods can rise by about 23%. The most affected are PPE items, such as aprons (52% increase), as well as goggles and masks (a 40% increase) [8]. Therefore, as HICs act to secure these crucial supplies, the LICs face much more difficult choices because their budgets are far more limited, and they typically lack local producers for most PPE items. They therefore have to rely on donors and multilateral organizations to meet their needs. Thus, the WHO has delivered 0.5 million sets of PPE, while UNICEF has donated 100,000 N95 masks and 4.3 million gloves and other PPE items [7].

3.5. Responding to the COVID-19 pandemic in LICs

HICs adopted various draconian measures that they deemed best in response to the pandemic, often out of panic and ignorance of other options. This led to the governments of many developing countries replicating such measures without accounting for their country's specific needs, circumstances, and challenges. The most important and obvious difference between developed and developing countries, with respect to COVID-19, lies in their economic resources. Most people in LICs live in rural areas, with most families sharing a single space and

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using communal facilities. Even basic hygiene and other sanitary measures are difficult to practice when clean running water is a rarity [17]. Thus many factors—including social, local, and economic ones—determine the decisions of public health officials in LICs, with these factors being vital for developing effective responses for coping with COVID-19.

There were two different basic responses to handling the COVID-19 pandemic in LICs, one that simply denied the pandemic's existence and another that took action to prevent the spread of the virus. Brazil and Peru are two example countries in Latin America that were worst hit by COVID-19.

In Brazil, there was impassivity, denial, and a lack of national and social solidarity. Brazilian President Bolsonaro chose to follow the example of America's President Trump in comparing the COVID-19 threat to a "little flu," even suggesting that it was a fantasy manufactured by the media. President Bolsonaro acted against his government's approach, with him dismissing preventive measures and firing his health minister [20].

Peru, on the other hand, imposed lockdowns, closed its schools and borders, and cancelled international flights, but the government's response ignored the country's socioeconomic conditions. Peru's poorest live in slums, and they had to stand long hours in line to receive cash relief grants, and this became a major cause of contagion [21]. The government also targeted its subsidies at large companies and little reached those in the greatest need [22]. For the poor in cities, it was practically impossible to follow the restrictions while struggling to survive. There were also corruption scandals involving the procurement of sanitary, protective, testing, medical, and other supplies, making the situation worth [22].

Nevertheless, developing countries tackled the COVID-19 pandemic at a far lower cost and still managed some impressive results. Some of their policy responses were very effective at coping with COVID-19. For example, in community consultations**,** governments invited religious leaders, local bodies, and civil society organizations to participate in designing and implementing policies. There was transparency and communication, with governments informing the public on a daily basis, explaining what was going on and providing essential epidemiological information to better understand the threat and related issues, as well as why health officials made decisions according to the situation. There was also a human face to lockdown, with some governments organizing the physical delivery of food, medicines, and other essentials, as well as providing necessary services to those under lockdown. This reduced the risk of hunger and starvation for the poorest segments of the population [23, 24].

3.6. COVID-19 vaccines in developing countries

The development of various vaccines to protect against a variety of infectious diseases is very important for the populations of LICs. However, vaccines are not yet available for many major diseases that affect LICs, such as HIV and malaria. In addition to the scientific challenges, there are also other issues affecting many developing countries, such as economic crises and political instability. There are also breakdowns in the primary healthcare infrastructure, such as for vaccine delivery. LICs also have limited funding for purchasing vaccines, and they also have weak surveillance capabilities. Added to all this are the demographic obstacles, with major problems relating to poverty. Moreover, such countries are often characterized by their relatively low economic means and an unstable political situation, so the high cost of vaccines makes them dependent upon the help of richer countries [25].

Many people in developed countries, meanwhile, had access to protection with the currently available vaccines, so there was a big gap between the vaccination rates in high- and low-income countries. LICs, with their high rates of poverty, were already struggling with

Technium Social Sciences Journal
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inequality related to the COVID-19 pandemic, and then there was inequitable access to the COVID-19 vaccines. By the end of November 2021, around 54.2% of the world's population had received at least one dose of a COVID-19 vaccine, but in the LICs, the rate was just 5.8% [26].

The gap in vaccination coverage between high- and middle-income countries compared with low-income countries was particularly stark [26]. Vaccination rates in Africa are particularly concerning. Indeed, about 40 countries still have less than a tenth of their populations fully vaccinated, the vast majority of these being in Africa. As of November 2021, Congo, Niger, Chad, and Burundi had 2.3%, 1.8%, 0.4%, and 0% of their populations fully vaccinated, respectively, compared with high vaccination rates in Singapore (91.9%), the United Arab Emirates (88.4%), and Portugal (87.8%) [26].

These example countries demonstrate the inequitable distribution of COVID-19 vaccines since they became available. There are various reasons for this: First, COVAX,[1] the global program for purchasing COVID-19 vaccines and distributing them to developing countries, has, from the start, struggled to secure enough vaccine doses. Nearly 100 low-income countries rely on this program, and COVAX initially aimed to deliver two billion doses of COVID-19 vaccines, just enough to vaccinate the most at-risk groups in developing countries, by the end of 2021. However, it had only actually delivered less than 576 million doses by the end of November and 1.425 billion doses by the end of the year. This failure was largely due to wealthy countries making pre-purchase agreements for more than half of the first 7.5 billion vaccine doses, leaving very few doses for COVAX to acquire. In addition, wealthy developed countries fail to deliver on their promised vaccine donations to low- and middle-income countries. They had committed to donating more than 1.3 billion vaccines to COVAX by October 25, but only around 10% of these were actually delivered [10]. Thus, the focus of global health protection remained, as ever in this pandemic, focused on protecting citizens in high-income countries [9].

4. Material and Methods

4.1. Sample description

To investigate the association between LICs with different GHI severities and indicators of COVID-19, the following measures were taken: This study considered four COVID-19-related indicators, namely the proportion of confirmed cases, deaths, recoveries, and vaccinated people. The considered countries were classified into three groups according to their GHI severity—namely low, moderate, and serious—and this was limited by data availability. Data was sourced from the Johns Hopkins Coronavirus Resource Center for January 2020 to August 2021, which corresponds with the onset of the pandemic through to the availability of the first vaccines.

[1] COVAX is the vaccines pillar of the Access to COVID-19 Tools (ACT) Accelerator.The ACT Accelerator is a groundbreaking global collaboration to accelerate the development, production, and equitable access to COVID-19 tests, treatments, and vaccines. COVAX is co-led by the Coalition for Epidemic Preparedness Innovations (CEPI), Gavi, and the World Health Organization (WHO), alongside key delivery partner UNICEF. Its aim is to accelerate the development and manufacture of COVID-19 vaccines and guarantee fair and equitable access for every country in the world. https://www.gavi.org/covax-facility

Technium Social Sciences Journal
Vol. 34, 347-361, August, 2022
ISSN: 2668-7798
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4.2. Measures and data analysis

Statistical modeling and analysis was performed to examine the relationships between 95 developing countries and the four daily COVID-19 indicators, namely the rates for confirmed cases, deaths, recoveries, and vaccinations.

In addition, this study investigated other relationships to highlight the differences among the three groups of LIC countries: mortality-to-recovered cases, recovered-to-confirmed cases, and deaths-to-confirmed cases.

Countries were referenced and classified into three groups according to their GHI severity rank.[2] This index considers four outcomes, namely the proportion of undernourished people in the population, the prevalence of wasting in children under five, the prevalence of stunting in children under five, and the under-five mortality rate (%). The GHI is a 100-point scale that can be then summarized into five levels of hunger on the GHI Severity Scale: low (≤9.9), moderate (10.0–19.9), serious (20.0–34.9), alarming (35.0–49.9), and extremely alarming (≥50.0). Table 1 summarizes this study's sample of 95 developing countries classified over three groups on the GHI Severity Scale. The choice of countries was constrained by data availability, because some developing countries do not regularly report data due to ongoing conflicts, lack of statistical capacity, and various other reasons.

Table 1. Study sample: Country classification according to GHI Severity Scale.

GHI Severity Scale*	No. of countries
Low ≤9.9	39
Moderate 10.0–19.9	18
serious 20/0–34.9	38
Total	95

Source: Own elaboration, *****Note that no data were available for the COVID-19 pandemic for countries with alarming and extremely alarming severities**.** https://www.globalhungerindex.org/about.html

5. Results

This section describes the two investigated relationship types, namely the relationships that severity has with the four COVID-19 indicators and the three relationships among the COVID-19 indicators.

5.1. A LIC's severity and the four COVID-19 indicators

The three groups of countries, being classified by their GHI severity level, exhibited specific behaviors for three of the examined indicators, namely confirmed cases, deaths, and recovered cases. The clearly distinct relationships between these three groups and each indicator are presented in Figures 1–4.

[2] The Global Hunger Index (GHI) comprises four component indicators: (i) The percentage of the population that is undernourished (PUN), (ii) the percentage of children under the age of five suffering from wasting (CWA), (iii) the percentage of children under the age of five suffering from stunting (CST), and (iv) the mortality rate of children under the age of five (CM). The GHI score for a country is calculated as (1/3 × Standardized PUN) + (1/6 × Standardized CWA) + (1/6 × Standardized CST) + (1/3 × Standardized CM) (GHI data source: https://www.globalhungerindex.org/).

Technium Social Sciences Journal
Vol. 34, 347-361, August, 2022
ISSN: 2668-7798
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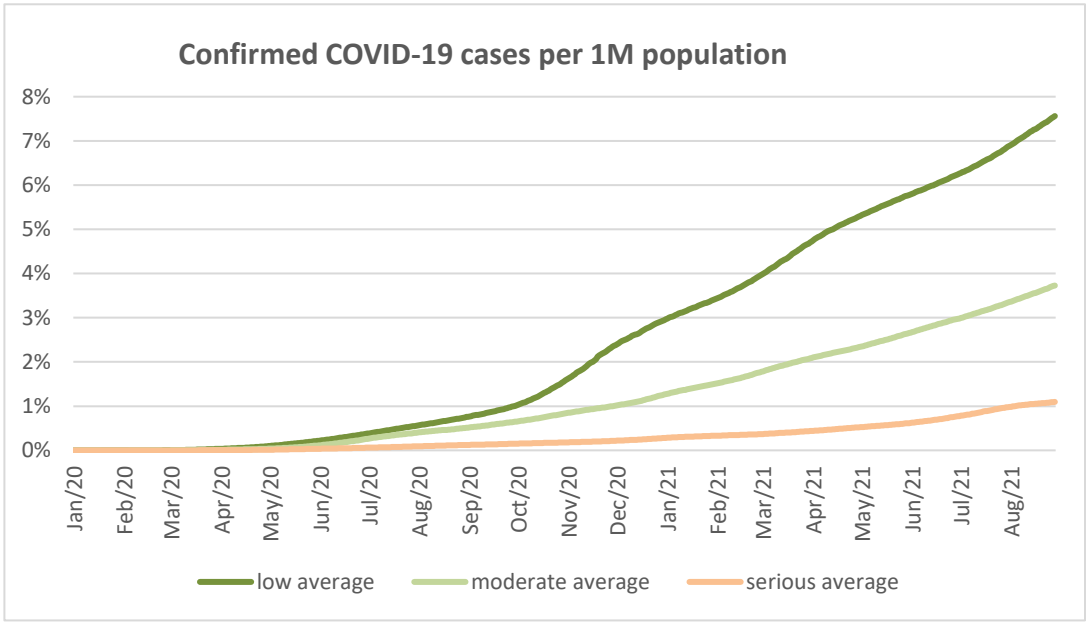

Figure 1. Confirmed COVID-19 cases per 1M population.

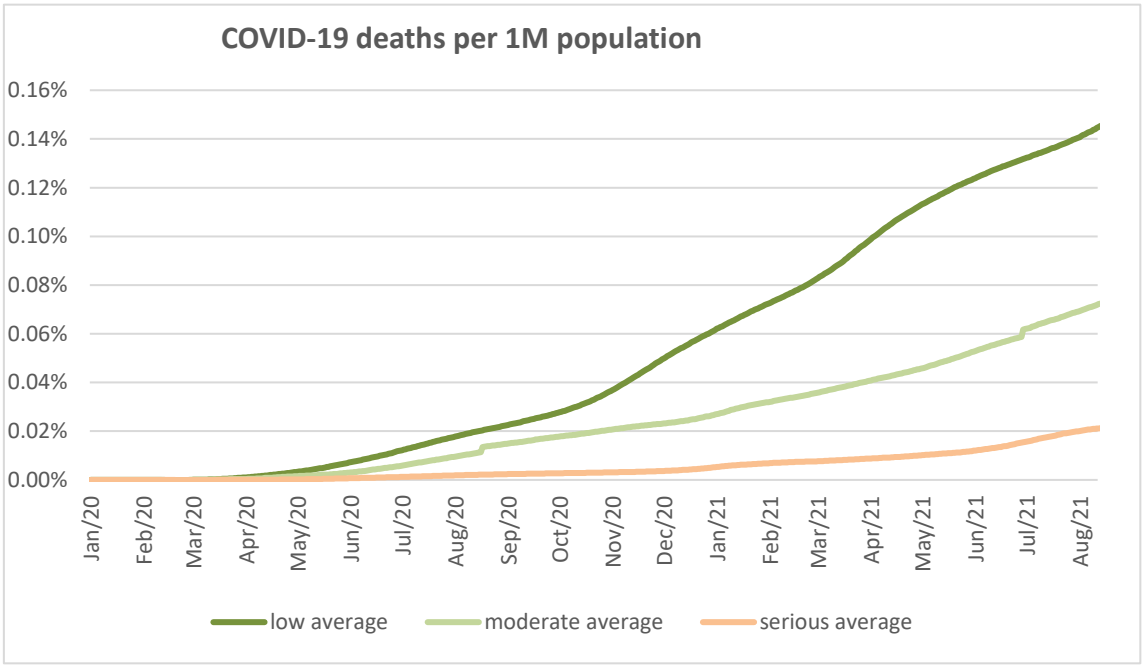

Figure 2. COVID-19 deaths per 1M population.

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Vol. 34, 347-361, August, 2022
ISSN: 2668-7798
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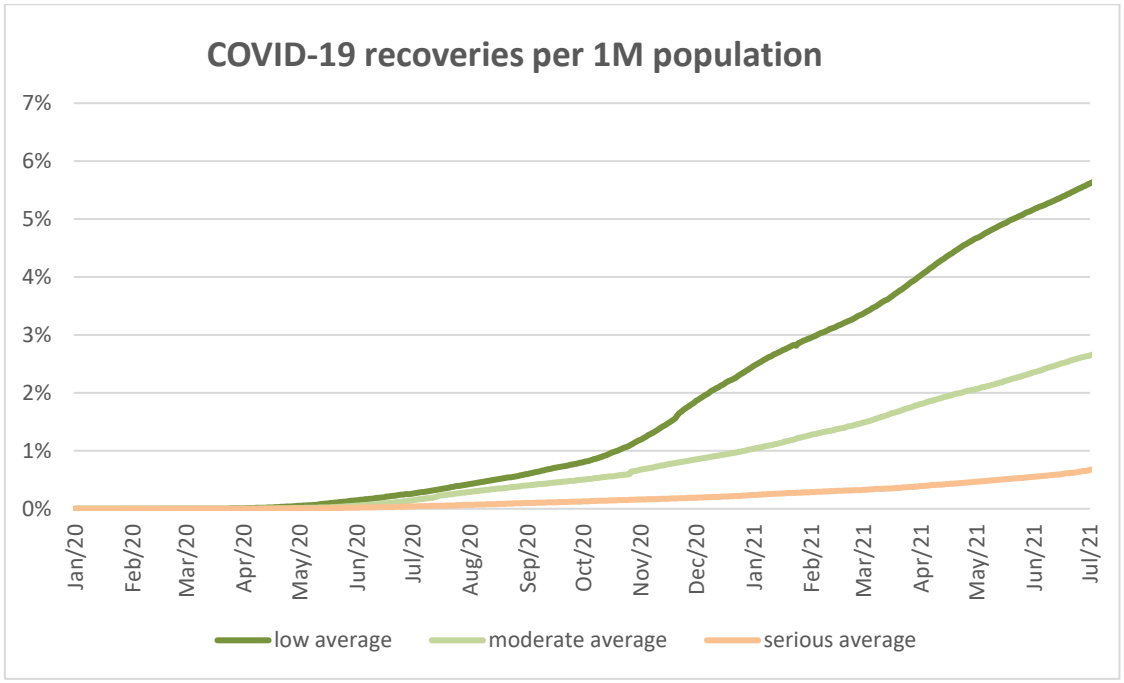

Figure 3. COVID-19 recoveries per 1M population.

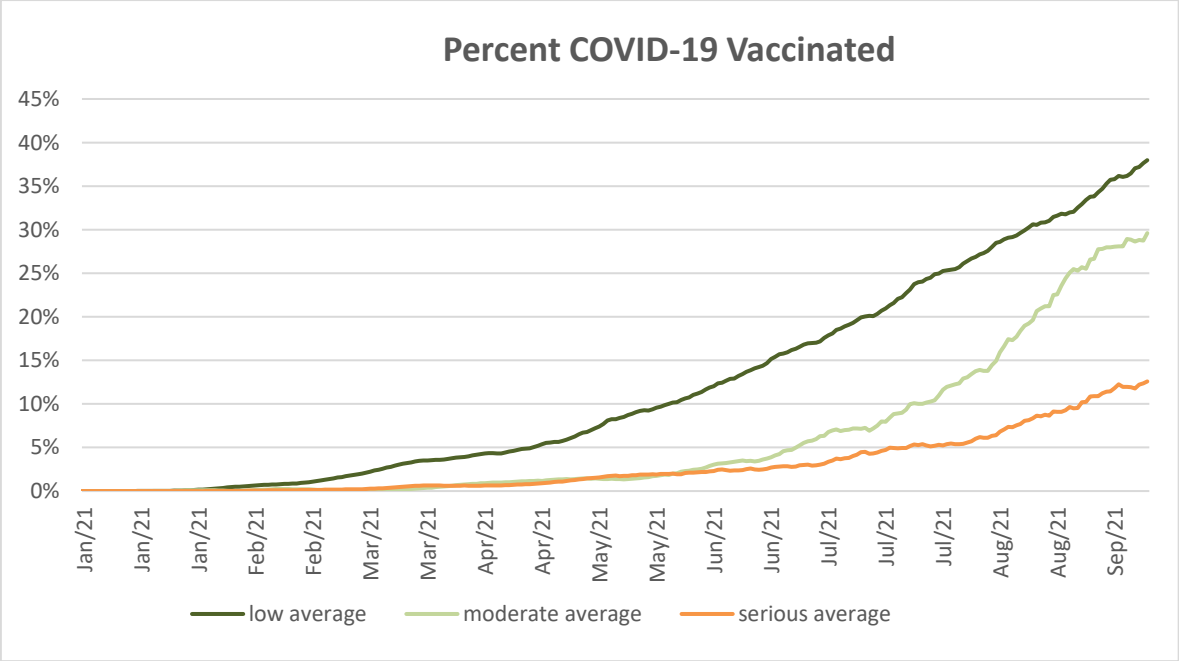

Figure 4. Percent COVID-19 vaccinated.

Table 2. Summary of results in Figures 1–4.

	Low	Moderate	Serious
Vaccination rate	33%	26%	13%
Confirmed case rate	7.5%	3.7%	1.1%
Death rate	0.14%	0.07%	0.02%
Recovery rate	5.6%	2.6%	0.6%

Technium Social Sciences Journal
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www.techniumscience.com

The four examined COVID-19 indicators presented in Figures 1–4 exhibit different progress rates for each group, reflecting varying capacities for coping with the COVID-19 pandemic. The findings can be summarized as follows:

i. Countries with low GHI scores vaccinated their populations faster than the other two groups of countries (moderate and serious).

ii. Countries with higher GHI scores (i.e., serious) had a lower rate of confirmed COVID-19 cases (1.1% vs 7.5%) and COVID-19 deaths (0.02% vs 0.14%), as well as a lower recovery rate (0.8% vs 5.8%).

iii. Countries with lower GHI scores (i.e., low or moderate severity) had greater levels of confirmed COVID-19 cases and deaths but also greater recovery rates.

iv. Countries with lower GHI scores also acted quickly on vaccinations, yet they had higher mortality rates.

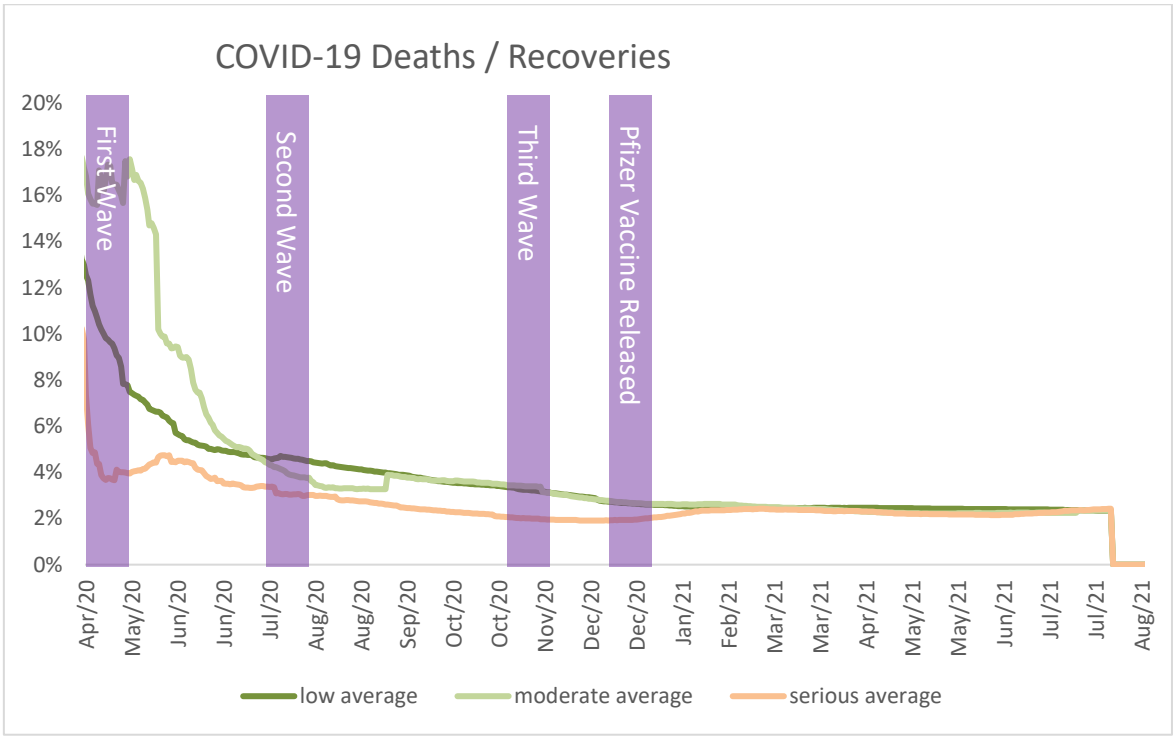
v. Countries with moderate and low GHI ranks achieved similar rates of vaccinations (30–40% of population), but countries with a serious GHI rank only vaccinated 13% of their populations on average. However, the number of COVID-19 deaths per confirmed case was unaffected by vaccinations.

vi. Countries with a serious GHI rank showed significantly fewer mortalities per confirmed cases (1.8% vs 3.4%) in 2020 (i.e., before the vaccines). In 2021, the rates were roughly equal among all three groups at 2%.

5.2. The three examined relationships between the COVID-19 indicators

The three examined relationships between the COVID-19 indicators give some useful insights into how countries perform over time. A different character was observed for each of the three examined relationships, which were COVID-19-deaths to confirmed cases, COVID-19 recoveries to confirmed cases, and COVID-19 deaths to recovered cases. These relationships are illustrated in Figures 5–7, wherein the four purple columns indicate the three COVID-19 waves between 2020-2021 (i.e., the first wave in April 2020, the second wave in July 2020; and the third wave in November 2020), as well as the release of the Pfizer vaccine in December 2020.

Technium Social Sciences Journal
Vol. 34, 347-361, August, 2022
ISSN: 2668-7798
www.techniumscience.com



Figures 5: COVID-19 deaths/recoveries.

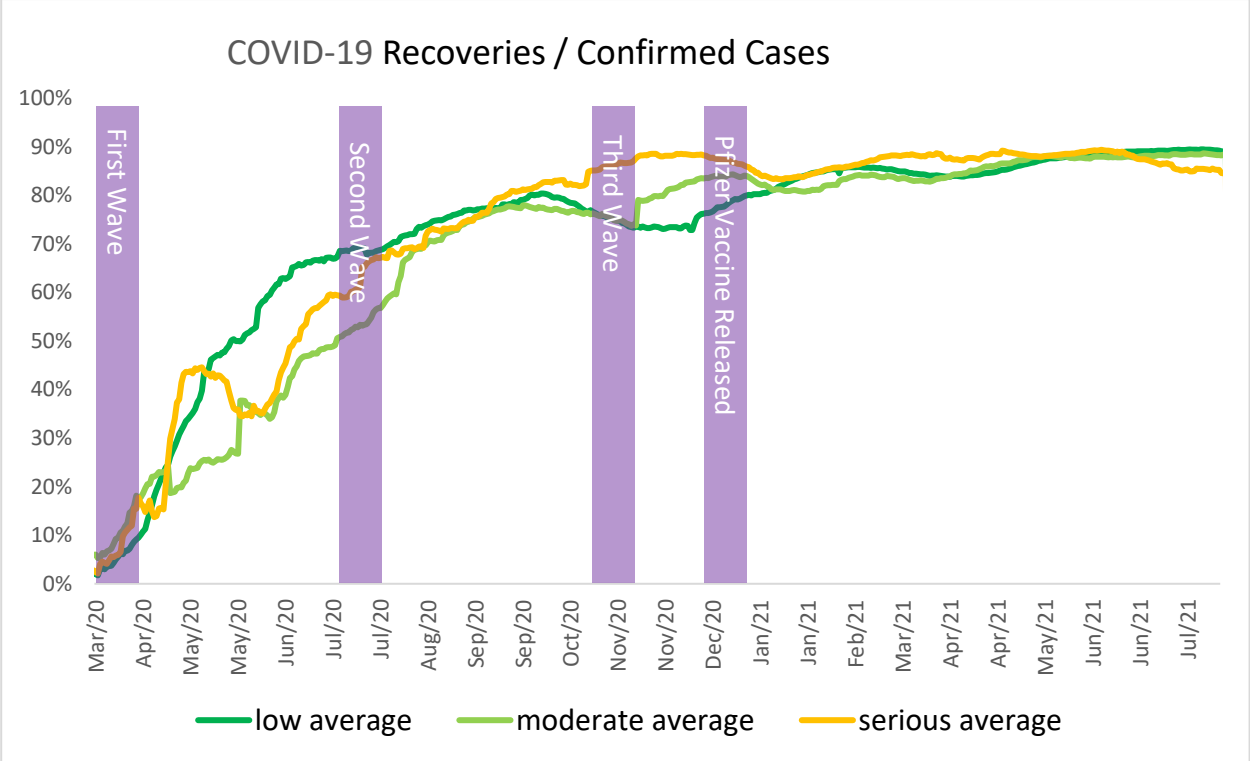


Figure 6. COVID-19 recoveries/confirmed cases.

Technium Social Sciences Journal
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www.techniumscience.com

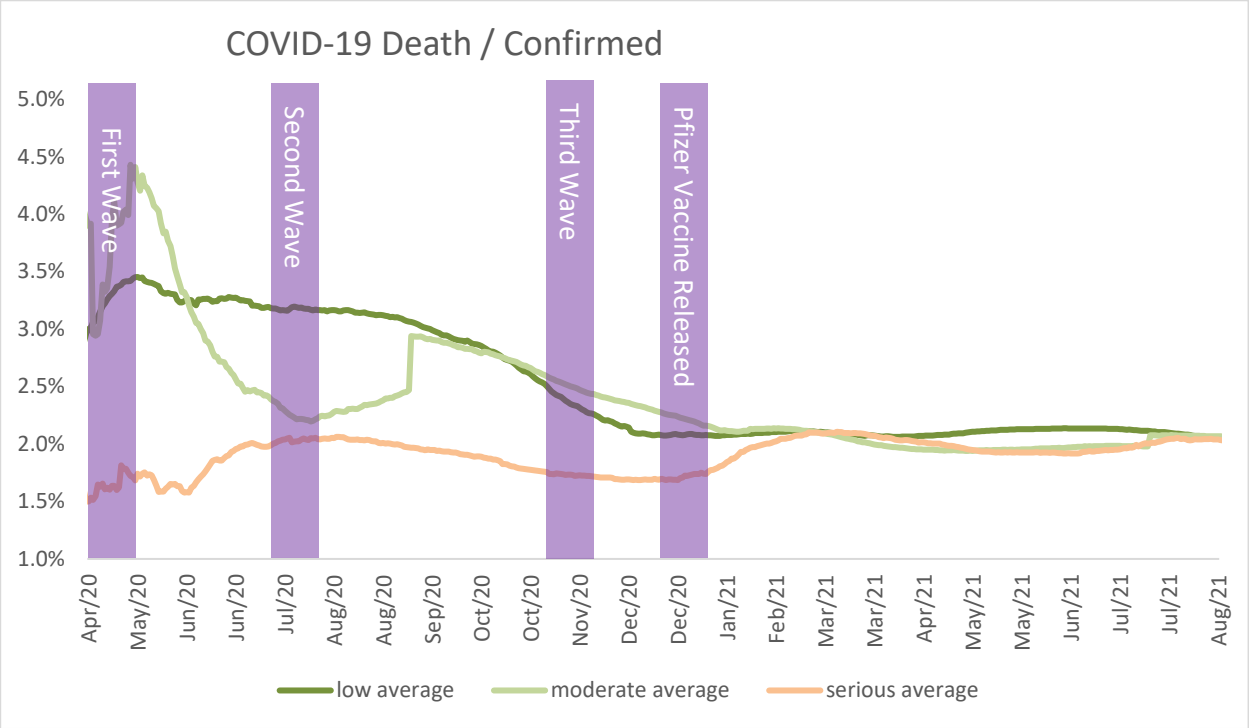

Figure 7. COVID-19 Death / Confirmed

The findings for Figure 5 (COVID-19 deaths/recoveries) can be summarized as:

i. Countries with moderate GHIs took more time to deal with COVID-19 and therefore experienced higher death rates until July 2020.

ii. Countries with low GHIs took just two months to reduce the COVID-19 deaths/recoveries ratio.

iii. Countries with serious GHIs, meanwhile, did not experience a high ratio of deaths to recoveries**.**

Figure 6 (COVID-19 recoveries/confirmed cases) shows that the rates for recoveries to confirmed cases became roughly similar once vaccinations became available. Figure 7, meanwhile, illustrates how the COVID-19 deaths-to-confirmed-cases rates were unaffected by vaccination. In Aug. 2021, mortality rates due to COVID-19 were largely similar among all three groups at 2%.

Thus, to summarize the findings from Figures 5–7:

i. LICs with serious GHIs experienced the lowest rates of COVID-19 confirmed cases, as well as deaths to confirmed cases, and similar recovery rates to those of LICs with low or moderate GHI severities.

ii. Countries with serious GHIs addressed COVID-19 much more effectively than those with low and moderate GHIs, but nevertheless, they need the world's support for greater deliveries of vaccinations.

iii. Countries with low or moderate GHIs required a greater level of support and a higher rate of vaccination to deal with the COVID-19 pandemic.

iv. All countries showed similar death-to-recovery rates, regardless of vaccination status or GHI severity.

Technium Social Sciences Journal
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6. Conclusion and Discussion

This study's conclusion focuses on four points of interest, as summarized in Table 3.

Table 3. Study's conclusion

No.	Point of interest	Details
1	LICs progress	A LIC's progress reflects its healthcare capacity for coping with the COVID-19 pandemic.
2	Intervention	A standardized set of interventions is unlikely to be universally applicable to all countries with different GHI severities.
3	A work plan	A work plan needs to be designed that considers a country's GHI severity, with operational steps then being taken to achieve a better response to any future health crises.
4	Dynamic measures	Governments and policymakers need to consider dynamic measures that track a country's progress.

Recommendations

This study highlights a need to improve the understanding of policymakers, especially when it comes to developing countries, because this is critical when designing and refining a country's response at various levels. The taking of sound operational steps by policymakers and governments is extremely important in low-income countries [4]. The proper measures have to be taken, ones that fit with a country's socioeconomic profile, to achieve effective results in coping with the COVID-19 pandemic. Governments and policymakers also need to consider developing specific emergency regulations that are appropriate to a LIC's GHI, because such an understanding can help greatly in dealing with the COVID-19 threat in a more effective way [4].

This study's finding suggests the solution to the COVID-19 problem in LICs may involve considering a country's GHI severity. Therefore, based on its results, this study recommends the following:

i. **Focused programs:** Countries with serious GHIs should prefer a focused approach that addresses their socioeconomic problems.

ii. **Broader Programs:** Countries with low and moderate GHIs should initiate broader healthcare programs to address the consequences of COVID-19 and improve their healthcare systems.

iii. **Comprehensive help**: Developed countries should help by providing healthcare support to countries with low or moderate GHIs, which should also consider improving their healthcare systems through a broader healthcare program.

iv. **Dynamic Intervention:** Governments and policymakers should monitor and dynamically adjust their policies to accelerate progression in strengthening their healthcare systems.

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