Evaluating Russia's Preparedness and Response to the COVID-19 Pandemic: An Analysis of Excess Death Rates and the Global Health Security Index*

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This study investigates the unexpected surge in death rates during the COVID-19 pandemic in Russia, a country considered well-prepared according to the Global Health Security (GHS) Index. Building upon Nuzzo and Ledesma's work, we analyze the impact of COVID-19 in Russia, incorporating factors such as the GHS Index and excess death rates. Our findings reveal a substantial increase in excess death rates in Russia, diverging from the lower rates observed in nations deemed well-prepared. This research contributes to our understanding of the repercussions of the COVID-19 outbreak in Russia, highlighting areas for improvement in prepared countries to mitigate the effects of future pandemics.

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*Code and data are available at: https://github.com/Ary4m3n/covid-effect-russia.git; Replication on Social Science Reproduction platform available at: https://www.socialsciencereproduction.org/reproductions/8938b287-6681-4a5e-8993-42011a51be58/index

1 Introduction

The global impact of the COVID-19 pandemic on public health, foreign policy, and economies has been profound, resulting in an unprecedented loss of life worldwide over the past five years (World Health Organization (Chriscaden 2020)). With over 774 million confirmed cases and more than 7 million reported deaths, these figures, considered to be undercounted, suggest an actual death toll ranging from 18.2 to 33.5 million based on excess mortality estimates (WikiCOVID (Wikipedia 2024)). The staggering number of deaths has prompted a critical examination of countries presumed to be well-prepared to handle such outbreaks and the factors contributing to their extensive impact.

Among the most severely affected nations, including India, the United States of America, Brazil and Mexico, Russia, a nation deemed well-prepared according to various metrics, was specifically chosen for this study due to its unexpected and disproportionately high death toll in the face of the pandemic. With over 230,000 reported COVID-19-related deaths, Russia holds the highest mortality rate in Europe and the second-highest in Asia (ThinkGlobalHealth (Pašović et al. 2021); Carnegie Russia (Stronski 2021)). This selection aims to uncover unique insights into the challenges faced by ostensibly prepared nations.

This paper replicates the methodology employed by Jennifer B. Nuzzo and Jorge R. Ledesma in their study, utilizing the Global Health Security (GHS) Index as an indicator of a country's preparedness against epidemics or pandemics like COVID-19 (RepPaper (Nuzzo and Ledesma 2023)). The choice of GHS is deliberate, considering its comprehensive evaluation of various health security capacities. This metric offers a nuanced understanding of a country's ability to prevent, detect, and respond to public health emergencies, making it a suitable choice over

other metrics. However, our focus extends to Russia, providing insights into the impact of the outbreak and proposing improvements for future pandemic mitigation efforts. Despite Russia's apparent preparedness, our reproduction reveals an unprecedented rise in the death rate compared to other countries, with one of the highest excess death rates globally. This prompts a crucial assessment that better planning and regulations are imperative to mitigate the impact of such outbreaks, a key aspect explored in this paper.

The structure of this paper comprises three sections: Data, Results, and Discussion. In the Data section (Section 2), we discuss the data source and the process of measuring and cleaning the datasets from the replicated paper (RepPaper (Nuzzo and Ledesma 2023)). The Results section (Section 3) summarizes the findings, presenting maps and plots to illustrate trends. The Discussion section (Section 4) delves into the analysis of our findings, exploring measures to prevent extensive effects of future pandemics on the country. Additionally, we discuss limitations and propose avenues for further research, concluding the paper.

2 Data

The dataset under examination in this study originates from the replication package associated with Nuzzo and Ledesma's paper (Nuzzo and Ledesma 2023). Employing the open-source `R` programming language (R Core Team 2023), we conducted the cleaning and analysis procedures, leveraging several R libraries and packages such as `tidyverse` (Wickham et al. 2019), `janitor` (Firke 2023), `ggplot2` (Wickham 2016), `knitr` (Xie 2023), `readr` (Wickham, Hester, and Bryan 2023), `dplyr` (Wickham et al. 2023), `rnaturalearth` (Massicotte and South 2023), and `sf` (Pebesma 2018).

Our data cleaning and analysis processes replicate those of the original paper, ensuring consistency in the datasets used. In terms of estimand, the primary focus of this analysis is to assess the preparedness of countries, specifically Russia, in addressing pandemics, and to gauge their success in controlling the associated impact. Key estimators include the Global Health Security (GHS) Index, offering insights into overall preparedness, and the excess death rate, serving as an indicator of the pandemic's impact.

The subsequent sections will provide a comprehensive overview of the raw data in (Section 2.1), delve into the intricacies of the data cleaning process in (Section 2.2), and subsequently, explore the measurement aspects in (Section 2.3).

2.1 Raw Data

This study replicates the data sourced from the replication package of Nuzzo and Ledesma's paper (Nuzzo and Ledesma 2023). Specifically, we utilize three datasets to investigate the assertion that Russia struggled to effectively manage the surge of the COVID-19 pandemic.

Despite the wealth of data available on the global impact of COVID-19, the comprehensive datasets provided by Nuzzo and Ledesma serve as the primary source for our analysis.

The first raw dataset encompasses the Global Health Security index for all countries, offering a wide array of indices, some of which are not pertinent to our study. Notably, this dataset spans the years 2019 and 2021; however, our analysis focuses exclusively on the GHS index for the year 2021.

The second raw dataset provides data on all-cause death rates for all countries from 1960 to 2021. The "all-cause death rate" refers to the overall mortality rate in a given population, considering deaths from all possible causes. It is a comprehensive measure that includes deaths from various diseases, accidents, and other factors. While this dataset contains extensive information, we restrict our analysis to data from 2010 onwards, as earlier years are deemed unnecessary for our COVID-19-focused investigation.

The third raw dataset, sourced from the Institute of Health Metrics and Evaluation (IHME), provides us information on COVID death rates, excess deaths, excess death rates, and the ratio of excess death rates to COVID death rates for countries globally. Similar to the preceding datasets, unnecessary information was present, requiring thorough data cleaning, a process detailed in Section Section 2.2.

The subsequent section (Section 2.2) will show the data cleaning process, elucidating the structure of the refined dataset employed in our analysis.

2.2 Cleaned Data

As outlined in Section 2.1, our initial step involves the first dataset concerning Global Health Security (GHS) indices for all countries globally. Presented in Table 1 are the first six countries along with their corresponding GHS indices. The dataset has been refined to include only two variables, namely Country Name and the respective GHS index. Cleaning involved the selection of these two columns and filtering the data specifically for the year 2021.

Table 1: Cleaned Data showing GHS indices for first 6 countries

Country Name	GHS Index
Afghanistan	28.8
Albania	45.0
Algeria	26.2
Andorra	34.7
Angola	29.1
Antigua and Barbuda	30.0

Moving to the second dataset covering all-cause death rates for countries from 1960 to 2021, the cleaned version is showcased in Table 2. To analyze Russia's position relative to other nations in terms of death rates, we filtered this dataset for the years 2010-2021, focusing on countries like India, South Korea, Russia, and the United States. The refined dataset structure is highlighted, enabling a clearer examination of death rate trends.

Table 2: Cleaned Data showing all cause death rates for 4 countries

Country Name	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
India	7.385	7.267	7.118	6.960	6.790	6.67	6.603	6.593	6.644	6.71	7.35	9.448
South Korea	5.100	5.100	5.300	5.300	5.300	5.40	5.500	5.600	5.800	5.70	5.90	6.200
Russia	14.200	13.500	13.300	13.000	13.100	13.00	12.900	12.400	12.500	12.30	14.60	16.700
United States	7.995	8.073	8.102	8.215	8.237	8.44	8.493	8.638	8.678	8.70	10.30	10.400

The last raw dataset, detailed in Section 2.1, originates from the Institute of Health Metrics and Evaluation (IHME), providing data on COVID death rates, excess deaths, excess death rates, and the ratio of excess death rates to COVID death rates for countries worldwide. While our primary interest was in the excess death rate and the country name, for a more comprehensive analysis of Russia's pandemic management, we integrated this data with the respective GHS index, showcased in Table 3. Consequently, this dataset comprises three variables: the country name, the respective excess death rate, and the GHS index.

Table 3: Cleaned Data showing Excess Death Rate and GHS index for first 6 chosen countries

Country Name	Excess Death Rate	GHS Index
Australia	-37.6	71.1
Austria	107.5	56.9
Brazil	186.9	51.2
Canada	60.5	69.8
Denmark	94.1	64.4
France	124.2	61.9

With the completion of the data cleaning phase and the generation of refined tables for analysis, our next section will delve into the Measurement (Section 2.3), offering an in-depth exploration of how the phenomena observed translated into entries in our dataset. Understanding this process is crucial for interpreting patterns and drawing meaningful conclusions from the data analysis results.

2.3 Measurement

With respect to measurement and accounting for the GHS index, it encompasses various measurements grouped into six broad categories: (1) prevention, (2) detection and reporting, (3) rapid response, (4) health system, (5) compliance with international norms, and (6) risk environment. These values are calculated based on the data available for each country which are self-reported and are then used to calculate the overall GHS index (Impact 2021).

A crucial data point for the COVID-19 pandemic is the excess death rate, representing the number of deaths occurring within a specific period above the expected baseline. The process of collecting this data is primarily overseen by Institute for Health Metrics and Evaluation (IHME), which collates information from various sources available for each country. Deaths included in the excess death rate calculation consists of those directly attributed to COVID-19, or in which COVID-19 appeared on the death certificates. For instance, deaths resulting from delayed treatment due to healthcare system strain caused by the pandemic are also accounted for.

Observation of deaths involves various mechanisms. Initially, healthcare facilities and authorities report COVID-19-related deaths through diagnostic tests and medical records. Deaths with an underlying cause of death of COVID-19 are not included in these estimates. For example, in some cases, COVID-19 may have contributed to the death, but the underlying cause of death was another cause, such as terminal cancer. Additionally, mortality statistics are compiled from death certificates and official registries. Tallying these deaths are then put into the Government's official records.

However, discussions surrounding COVID-19 present several challenges, including: (1) issues related to underreported or missing data, which can occur due to societal stigma at the local level, or countries intentionally concealing data to portray preparedness; (2) the absence of a universally accepted definition for COVID-19 deaths, leading to potential measurement inaccuracies; (3) the vast geographical expanse of countries, posing logistical hurdles in data collection and reporting efforts; and (4) disparities in testing methodologies and resource availability across regions, further complicating data interpretation.

Many countries, particularly nations such as India, Brazil, and Russia, which had the highest death count, faced the aforementioned challenges. This presents a significant obstacle in accurately gauging the pandemic's toll within a country. For instance, the excess death rate, a key metric in our analysis, serves to estimate the pandemic's impact. However, due to data truncation and measurement errors, the actual death rate may not always be precisely captured. Consequently, inaccuracies arise in calculating the excess death rate, introducing measurement errors that undermine the reliability of both the actual death rate and the excess death rate in data analysis.

The subsequent section (Section 3) will present the results of our analysis, offering insights into Russia's preparedness and response to the COVID-19 pandemic, and the implications of the findings.

3 Results

The results section is divided into four parts where all together we aim to look at Russia's capability according to the GHS index to tackle pandemics (Section 3.1), then compare Russia's all-causes mortality rate trends with those of other countries like India, South Korea and the United states (Section 3.2), then using those trends we dive into Russia's excess death rates while comparing them with other countries (Section 3.3) and finally study the relationship between the excess death rate and GHS index for Russia along with a subset of countries in the world (Section 3.4).

3.1 Global Distribution of Global Health Security Index (GHS) in 2021

As outlined in Section 2.1, the Global Health Security (GHS) index serves as a metric indicating a country's preparedness to address epidemics or pandemics, such as the COVID-19 outbreak. Reflecting both the robustness of the healthcare system and the regulatory framework, a higher GHS index suggests a more secure and well-prepared nation. Figure 1 presents a world map illustrating countries shaded based on their GHS indices. This replication of figure 1 from Nuzzo and Ledesma's paper (Nuzzo and Ledesma 2023) provides an overview of global preparedness.

Noteworthy observations reveal countries like the United States and Australia boasting some of the highest GHS indices, indicating exceptional preparedness for epidemics. Countries like Russia and China, while moderately prepared compared to the former, still exhibit a substantial level of readiness. Conversely, nations such as Venezuela and Yemen rank among the least secure.

Figure 1 provides us essential contextual information on Russia's preparedness in the face of epidemics and pandemics. Positioned favorably, Russia emerges as well-prepared compared to numerous countries deemed less secure. This background sets the stage for meaningful analyses throughout the paper, particularly in Section 3.2 and Section 4.

3.2 Trend in Death Rates for Russia, India, South Korea and United States

We proceed to examine the trends in all-cause death rates per 1000 population from 2010 to 2021, encompassing both COVID-related deaths and non-COVID-related fatalities, as well as the trend in excess death rates per 100 population in 2020 and 2021 in the subsequent section. Figure 2 presents the trends in all-cause death rates per 1000 population from 2010 to 2021 for India, South Korea, Russia, and the United States, utilizing data from Table 2. From 2010 to 2019, a general gradual decrease in death rates is evident for Russia and India, juxtaposed with a gradual increase observed in South Korea and the United States. The dashed line represents the line of best fit for the years 2010-2019.

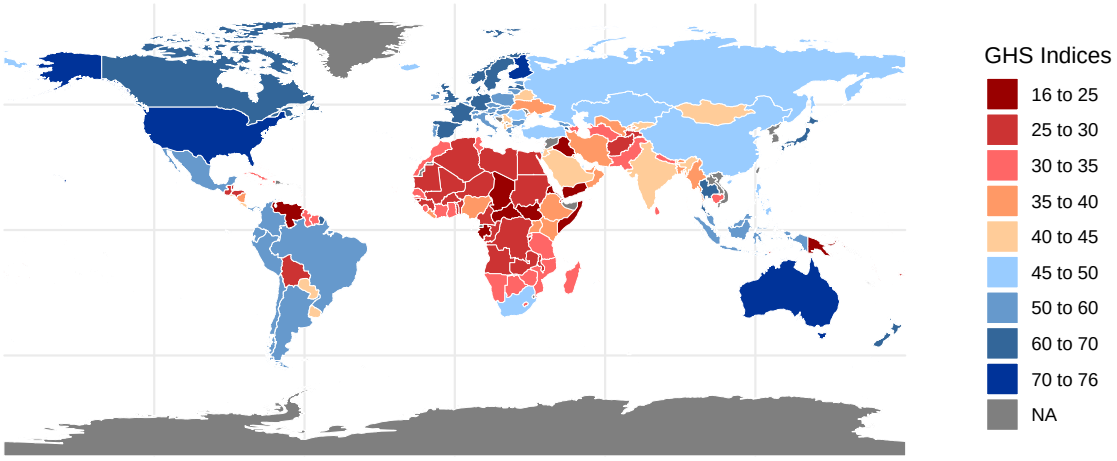

Figure 1: Global Distribution of Global Health Security (GHS) Index Scores in 2021

From Figure 2, a notable surge in death rates is observed in 2020 and 2021, particularly pronounced in Russia compared to other countries. It is noteworthy that despite India's lower GHS index compared to Russia, the observed increase in death rates during 2020 and 2021 was not as substantial as in Russia. The dotted line represents the trend line for the years 2010-2021. Comparing Russia to South Korea, the dashed (2010-2019) and dotted (2010-2021) lines closely align for South Korea, indicating a relatively consistent trend without a significant increase in unexpected deaths during COVID-19. Conversely, for Russia, the divergence between the two lines implies a notable increase in unforeseen deaths during this period.

3.3 Excess Death Rates

Considering the likelihood of undercounting COVID-19 deaths, our focus shifted to analyzing excess death rates for the years 2020 and 2021 to provide a comprehensive measure of the pandemic's overall mortality impact. Drawing inspiration from Nuzzo and Ledesma's method-

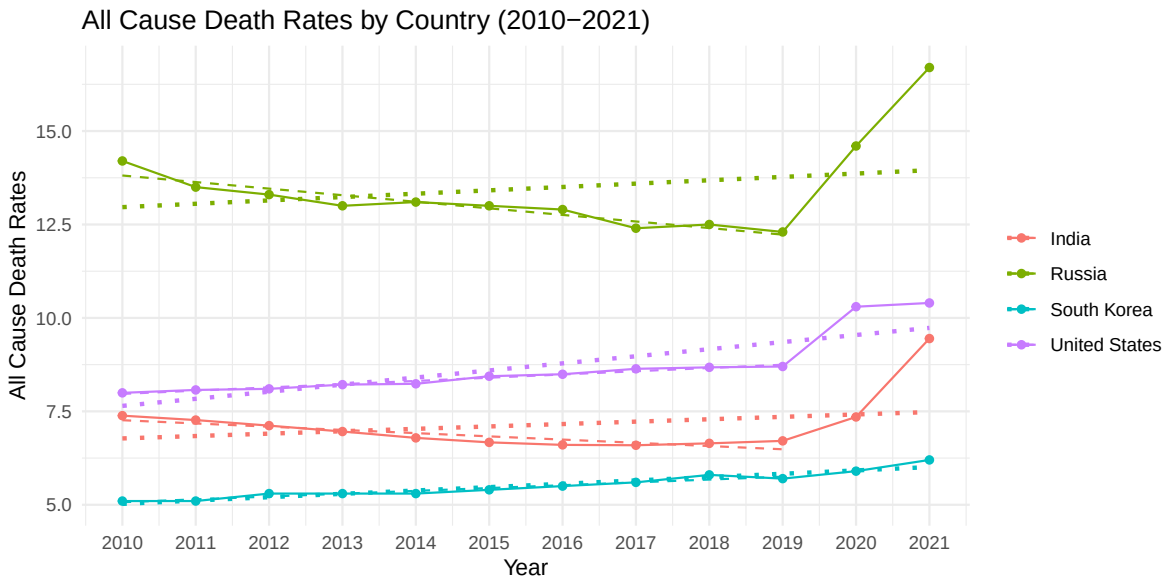

Figure 2: All Cause Death Rates per 1000 Population for India, South Korea, Russia and United States (2010-2021)

ology (Nuzzo and Ledesma (2023)), which compared observed deaths during the pandemic to expected deaths extrapolated from historical trends, we utilized a similar model. Extrapolating the dashed line of best-fit from 2010-2019 to 2020 and 2021 allowed us to determine the expected death rate for each country. The subsequent plotting of the difference between expected and actual death rates, termed the excess death rate, unveiled insights into the pandemic's impact on mortality.

Our calculated values of excess death rates are presented in the figure labeled "Excess Death Rate" (Figure 3), showcasing the rates for Russia, India, South Korea, and the United States in 2020 and 2021. Simultaneously, the figure labeled "All-Cause Death Rate" (Figure 2) illustrates the trend in all-cause death rates for the same period. This simple models provides a nuanced understanding of the excess death rates, contributing valuable insights into the broader mortality implications of the COVID-19 pandemic.

In Figure 3, a considerable contrast is evident, particularly highlighting the substantial difference in excess death rates for Russia compared to other countries. The comparison with South Korea, as depicted in Figure 2, reinforces the minimal impact of the COVID-19 pandemic on South Korea, while Russia experienced a notable surge in deaths from 2019 to 2021. Comparing Russia to India, designated as less secure in the context of epidemics, the excess death rates for Russia in both 2020 and 2021 significantly exceed those for India. This observation will serve as a crucial point of reference in our ensuing discussions in Section 4.

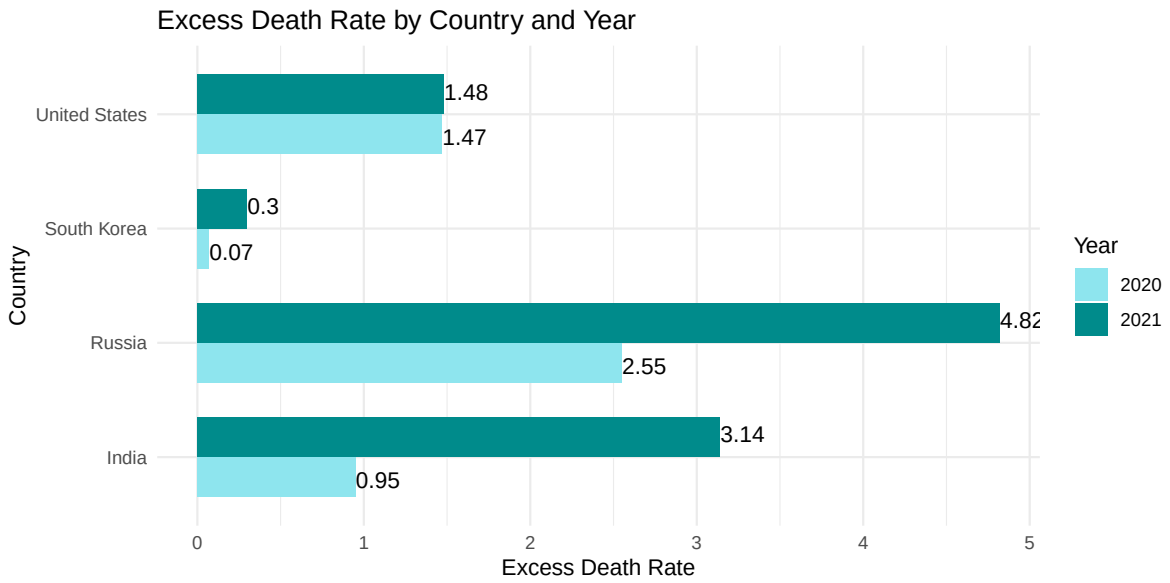

Figure 3: Excess Death Rates per 1000 Population for India, South Korea, Russia and United States, 2020 and 2021

3.4 Relationship between the Excess Death Rate and Global Health Security Index (GHS)

Finally, we delve into the relationship between the excess death rate and the Global Health Security (GHS) index for a subset of countries per 100,000 population. Figure 4 visually represents this subset of countries scattered on the plot based on their excess death rate and GHS index, as detailed in Appendix Table 4. The green line signifies a general decreasing trend, suggesting that as the GHS index increases, the excess death rate tends to decrease – indicating that more "secure" or well-prepared countries generally experience lower excess death rates.

Russia, highlighted in red, stands notably above the line of best fit, indicating that its excess death rate exceeded expectations. In contrast, countries like Brazil and Indonesia, with comparable GHS indices to Russia, align more closely with the line of best fit. India, despite having a lower GHS index than Russia, exhibits a substantially lower excess death rate.

Figure 4 prompts further exploration in Section 4, where we will delve into the implications and potential factors contributing to Russia's disproportionately higher excess death rate compared to countries with similar or even lower GHS indices.

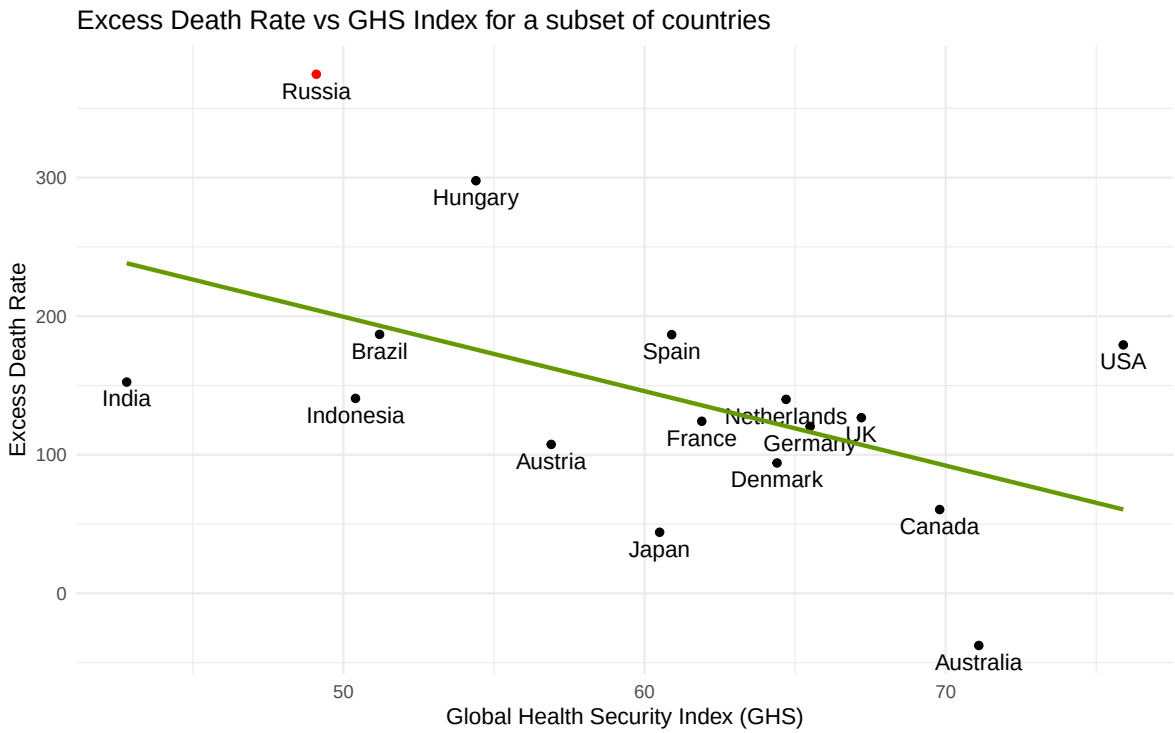

Figure 4: Relationship between the Excess Death Rate and the Global Health Security Index (GHS) per 100,000 Population for a subset of countries, 2020-2021

4 Discussion

4.1 Findings: Russia, Excess Deaths and what went wrong during the COVID-19 pandemic

In this paper, we have replicated the paper by Nuzzo and Ledesma (Nuzzo and Ledesma 2023), where they focused their analysis on the United States and studying how the world's best prepared country still couldn't control the pandemic. Our paper has instead shifted the focus to another global power and fairly well prepared country Russia, where we found out that Russia, when compared to a subset of other countries:(1) had one of the highest increase in all cause death rate in 2020, and (2) had one of the highest excess death rate caused by the pandemic in 2020 and 2021, as observed in Figure 2 and Figure 3. Our paper also found and observed the relationship between the GHS index of a country and its excess death rate in Figure 4, where Russia was seen as an outlier, where it lied a lot higher than the line of best fit implying a higher excess death rate than the other countries around it, even with a similar GHS index.

The main question that this paper tackles is, what exactly did Russia do wrong during the

pandemic considering it was the first country to roll out a vaccine? According to a report by Carnegie Endowment for International Peace, by late October 2021, only one-third of the Russian Population had been fully vaccinated against the virus, where other countries like Argentina and China had 56% and 76% of their populations respectively, fully vaccinated by then (Stronski 2021). According to reports, one of the main concerns for people being skeptical about the Sputnik V vaccine was that they did not trust that the vaccine would be effective or even safe to use. Another reason for the residents of Russia being skeptical was that Russian President Putin hesitated for months after the release of the vaccine to himself get vaccinated (Stronski 2021). I believe that this must have slowed down the rate at which people in Russia were getting vaccinated hence leading to unprecedented deaths as a result.

Another possible reason for Russia not being able to tackle the pandemic well was that the quarantine measures during the outbreak in 2020 and 2021 were generally very sporadic and short (Yaffa 2021). It was reported that at a time when the cases testing positive reached nearly ten thousand a day, the government put lockdown restrictions but that too only for a week, before everything opened back up. I believe this would have been a huge contributing factor to the extremely high excess deaths as more people would have contracted the virus coming in contact with each, hence spreading it more. Additionally, keeping in mind that at this time, as aforementioned, Russia only had approximately one thirds of its population vaccinated, this would have hit the residents of the country really hard.

In Section 4.2, we will discuss the measures that Russia could have taken to tackle the pandemic in a better way, and also measures that can be taken for future pandemics.

4.2 Russia and Improvements for the future

I believe that, as fast as Russia was at releasing the vaccine, maybe the government could have focused on mass producing and advertising the vaccine as a necessity as well. I believe that as soon as there is any skepticism in regards with vaccines, people will choose not to get one. As mentioned above, this will lead to the virus spreading even faster and eventually to more deaths too. In order to prevent this, the government should show the residents of the country that the vaccine is trustworthy and effective. It is essential to note that in order for this to work, the vaccine's efficacy and safety will also have to be proven to prevent from any ethical implications rising.

It was claimed that at the beginning of the outbreak, Russia was trying to downplay the threat of virus, however, with time they realized how lethal it actually was (Stronski 2021). According to me, it is very essential for a country to recognize the potential threat from any epidemic or outbreak and then make laws, and rules and regulations around it to quickly contain the situation before it gets worse. For countries as large as Russia, it might be a particularly challenging task to get such a large population that is spread out under control, but if the right procedures are set in place to tackle such situations, it can be manageable. Additionally, it is essential in these situations to also have firm rules in place for quarantining and lockdowns

to prevent the virus from spreading. This is especially even more important in the early stages of the outbreak when there is no vaccine in place to prevent the citizens of a country from contracting the virus. Some countries during the COVID-19 pandemic were very strict with their restrictions and lockdowns, and hence experienced way lesser deaths when compared to other countries which were more relaxed. In the future too, for Russia to be able to control the situation early on, better and more strict regulations will be required.

4.3 Accounting for Bias and Ethical Implications

It is essential to take into account an unintended but highly likely bias that might have taken place in this paper. While working on the paper, we realized that in creating Figure 2, Figure 3 and Figure 4, selection bias might have been involved in make decisions on which countries to plot on the graphs. Specifically, we used 4 countries in Figure 2 and Figure 3 to show the unique trends for Russia during the pandemic. Maybe if we chose a set of different countries, some countries would have performed more like Russia and consequently would have impacted our analysis. Similarly, in Figure 4 choosing a different subset of countries might generate a completely different line of best fit which might not have satisfied our exploration in the paper. However, at the same time, it is essential to note that the set of countries chosen in this paper has mostly been random and some countries like India and the United States have been shown constantly to create parallels between the impact of the pandemic on both the countries.

It should be noted that different countries employ varying methods of reporting their data, including mortality rates and excess death rates. Therefore, this study primarily relied on observational data, but it's crucial to account for differential biases in the data. For instance, some countries might underreport their deaths, while others might overreport them. Such discrepancies directly impact the analysis conducted in this paper.

Furthermore, COVID-19 policies were predominantly implemented at the state and local levels, introducing variability throughout the pandemic. Differences in policy implementation among these communities, coupled with the presence of unmeasured differences, complicate the ability to draw causal inferences.

There are a few ethical implications that we found while working on the paper. Mainly, sometimes the data can be incomplete or hidden which is misleading while analyzing that data. It is essential to keep that into account when looking at a report as, if for in this case any data for the deaths were incomplete, that would directly impact how we deem Russia to have tackled the pandemic. This is not just applicable for Russian data, but if other countries' data was missing, it would alter a major part of the analysis done above.

4.4 Weaknesses and Further Scope

While working on the paper we came across a few weaknesses that can be built on to make the report even more sound. Firstly, we could have tried to take into account the selection

bias by choosing the countries except Russia randomly. It is obviously impractical to include all 195 countries in all plots, hence choosing a completely random subset of countries could have reduced the selection bias. However, it is also essential to note that it is preferable to compare Russia with countries with the same infrastructure and stature in the world, as that makes the comparisons more sound. Comparing Russian data with random countries might have led to this paper being less informative and less analytical. Then, another weakness was that while making Figure 1 it was observed that the raw data file did not actually contain the GHS indices for all the countries around the world, for example, specifically Greenland was excluded from the dataset, which was the reason why some of the countries in the figure are shaded in grey showing that data was not available for them. If all the data was present for the figure, the analysis could have been even more sound.

As a further scope, an extension to this report could include taking into account the proportion of population vaccinated for a country in 2021. Taking this factor into account, we would be able to clearly point out one of the prominent reasons why Russia might have lacked in their attempt to tackle the pandemic. Alternatively, we can flip the question for this paper around and delve deeper into the countries with the lowest GHS indices which surprisingly did better than expected. This would help us analyze the paper in positive notion, taking into account all the right things they did that led to them tackling the outbreak better than many well-prepared countries.

In conclusion, we have observed that over 2020 and 2021, Russia failed to properly control the spread of the pandemic, and also effectively get its population vaccinated, which consequently lead to a large number of positive cases and deaths around the country. For future epidemics and outbreaks, Russia needs to make strict regulations and procedures which will help them contain the virus and not let it spread in the country and cause enormous amount of deaths.

Appendix

A Additional data details

Country Name	Excess Death Rate	GHS Index
Australia	-37.6	71.1
Austria	107.5	56.9
Brazil	186.9	51.2
Canada	60.5	69.8
Denmark	94.1	64.4
France	124.2	61.9
Germany	120.5	65.5
Hungary	297.8	54.4
India	152.5	42.8
Indonesia	140.7	50.4
Japan	44.1	60.5
Netherlands	140.0	64.7
Russia	374.6	49.1
Spain	186.7	60.9
UK	126.8	67.2
USA	179.3	75.9

Table 4: Cleaned Data showing Excess Death Rate and GHS index for a subset of countries

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