RAIS
August 8-9, 2024
RESEARCH ASSOCIATION for INTERDISCIPLINARY STUDIES
DOI:10.5281/zenodo.13916432

Multi-Year Impact of Health Obstructions on COVID-19 Fatalities in Post-Coup Myanmar

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Abstract. Myanmar's coup d'état of February 2021 deposed the democratically elected civilian administration with a military dictatorship, destabilizing the region with internal conflict and undue political imprisonments in the backdrop of the COVID-19 pandemic. Consequently, the sudden overthrow of the government revealed the fatal implications of politicizing public health crises and serves as a prominent modern representation of an unjust seizure of power and bioweaponization. However, existing literature has relied predominantly on qualitative data to describe the unsettling humanitarian crisis in Myanmar, insufficiently highlighting a fraction of a multifaceted campaign against human rights. To address this significant gap in understanding, the current work departs from the qualitative focus of existing studies, and instead leverages quantitative methodology to draw relationships between socio-political factors, healthcare obstruction (e.g., 'Health Workers Killed', 'Forceful Entry into Health Facility'), and multi-year COVID-19 fatalities in Myanmar (2020-2023). Multivariate regression analysis results show significant associations between healthcare obstruction, vaccination uptake, testing, new cases, and COVID-19 fatalities, signaling that every additional incident of either healthcare obstruction, new COVID-19 case, or recorded testing incident is related to a staggering increase in COVID-19 fatalities. The findings emphasize the urgent need to address the weaponization of pandemics through political and public health interventions by authoritarian powers. Furthermore, this study highlights yet another large-scale humanitarian crisis in Myanmar and sparks a debate on the fundamental constitution of preventing the effects of disease weaponization and bio-warfare at the national and international levels.

Keywords: COVID-19, Multivariate Regression, Human Rights, Public Health, Myanmar

1 Introduction

As of 1st February 2021, Myanmar was overtaken in a coup d'état, effectively bringing all economic, social, and political reforms to a halt and driving citizens to the streets to organize protests throughout the country in a campaign named the Civil Disobedience Movement (CDM) [1]. In response, citizens faced direct retaliation from the coup regime in the form of arbitrary detentions and gunfire, to name a few. In addition, the military also used numerous indirect measures, including preventing healthcare access to civilians, to curb the number of CDM-ers out on the streets protesting. With COVID-19 as a backdrop, compounded by the military's active interference with health workers, the country's pandemic response, along with its healthcare system, essentially collapsed, resulting in rising COVID-19 fatalities [2].

Current papers on the issue depict discouraging perspectives on Myanmar's already bleak healthcare system. Insecurity Insight's July 2023 update on violence against or obstruction of healthcare in Myanmar has highlighted that just between January and August of 2022, the State Administrative Council (SAC) executed airstrikes and artillery fires targeting healthcare infrastructure [3]. Previous studies have focused on the vulnerability to COVID-19 experienced by the internally displaced people (IDPs) of Myanmar [4], as well as first-hand testimonies of affected protesters and frontline medics regarding the issue, in addition to noting the public's significant mistrust of the military rolled out vaccines [5]. Despite existing investigative analysis in the context of Myanmar, there is limited progress in terms of quantitative research for specific relativity with respect to association between events of obstruction against healthcare and incidences of COVID-19 fatalities.

Through regression analysis, this paper explores the effects of the obstruction of the healthcare system on COVID-19 fatalities in the context of Myanmar, for the period 2020 to 2023. As the thesis anticipates finding a positive association between health workers obstructed and fatalities of COVID-19, this research is expected to provide insight on the implications of conflict amidst a pandemic. It also aims to provide reference on the broader topic of disease weaponization/bio-warfare in relation to international policy and regulations.

Hypothesis for this paper's research is as follows:

Hypothesis: The variable for incidents of obstruction against healthcare (IDT_total) has a positive lagged association with the variables for COVID-19 fatalities (new_deaths_smoothed) and vaccination uptakes (new_vaccinations_smoothed), as well as new COVID-19 testing (new_tests_smoothed) and cases (new_cases_smoothed), respectively.

Previous papers, inclusive of those by Nisha [6] for Kashmir Valley, India, Ayyash [7] for Palestine, and Qaddour and Fallon [8] for Syria, have primarily focused on the qualitative political perspectives of healthcare crises that are closely related enough to grapple with the political landscape of Myanmar and its pandemic crisis. As such, this thesis addressed this research gap in the specific context of Myanmar, using quantitative methods to better understand the impact of the deterioration of the public health system, as well as its severity, in the context of COVID-19.

This thesis explored the data sources and variables used to derive hypotheses, in relation to the background context via initial trends analysis. Research design for this study involved SARIMAX models and OLS multivariate regression on COVID-19 fatalities (new_deaths_smoothed), the dependent variable, and incidents of obstruction against healthcare (IDT_total), which is the independent variable, along with other selected variables, including vaccination uptakes (new_vaccinations_smoothed), new COVID-19 testing (new_tests_smoothed) and cases (new_cases_smoothed). The paper primarily explores the relationship between incidents of obstruction against healthcare, in terms of obstruction against health workers, facilities and supplies, and COVID-19 fatalities in Myanmar for the period 2020 to 2023.

2 Literature Review

2.1 Myanmar's Unanticipated Containment of COVID-19

With Myanmar's historically lacking healthcare infrastructure, the entire health system was expected by many to cripple in the face of COVID-19. As of the most recent data available before the pandemic, Myanmar had a ratio of only 6.7 doctors per 10,000 individuals, along with only 0.71 intensive care unit beds and 0.46 ventilators per 100,000 people [9]. Despite the grim statistics, Myanmar, which was then under the pre-coup civilian democratic administration, the National League of Democracy (NLD), was able to contain the first wave of the pandemic from late March to early August 2020 with just 360 cases and 9 fatalities total for a population of well over 53 million [10]. However, the situation shifted in mid-August, marked by the onset of community transmission in Sittwe- pivotal towards Myanmar's fight against COVID-19. This event led to the emergence of a second wave, and by October 2020, the nation witnessed unprecedented monthly peaks in new cases, reaching 39,333, along with a record high in deaths, totaling 927 [11].

Resultant of experience accumulated from the first and second waves, Myanmar quickly launched an onset of extremely aggressive COVID-19 measures, while the rest of the world debated on the efficacy of masks in public. Myanmar was able to execute a comprehensive public health response, encompassing testing initiatives, quarantine facilities, food and cash assistance programs, and strengthening of healthcare policies, much more rigorously and extensively than initially anticipated. The NLD administration also doubled down an aggressive campaign of containment measures with flights from Wuhan, China, completely banned from the getgo by January 2020 [12]. An inter-ministerial prevention and coordination committee was also set up immediately to tackle the pandemic, as well as coordinate and implement a cross-sector emergency response plan together with the Ministry of Health and Sports (MoHS), publishing regular situation reports for the populace [9].

The general sentiment of the public on the government's efforts toward managing COVID-19 was favorable, with unanimous agreement of officials doing the best they can given limited resources with many left impressed by the conduct of the inter-ministerial committee, seeing as this was the first time Myanmar faced a national-level health crisis of this magnitude [9].

2.2 The Military Regime, CDM and the Weaponization of COVID-19

In accompaniment with the rest of the country, Myanmar's health workers joined CDM and took to the streets, striking in defiance of the coup [1]. Just days following the takeover, more than 70 hospitals shut down, with a growing online movement proclaiming the junta to be illegitimate [13]. In addition to CDM, health workers banded together to launch a Red Ribbon Campaign [14] that by March, it was reported that a third of public hospitals had closed down due to a lack of personnel, with more than 50,000 out of 110,000 employees of MoHS opting to join CDM [10]. The nationwide striking of health workers collapsed Myanmar's testing infrastructure, where just a week before the coup, there were 17,000 reported tests per day on average with this figure plummeting to below 1,200 tests a day on average just a week following the coup [15] - note that this was happening parallel to ongoing protests with no consideration for distancing measures, as the entire nation collectively shifted its focus from the COVID-19 pandemic to overthrowing the newly self-initiated military dictator. Not only did treatment and infrastructure collapse, the junta also played an active part in hindering health responses through attacks against both health workers and health infrastructure [3]. The regime responded to the striking population of health workers with great force and they were declared in violation of their professional oaths with the arrested being charged under the Natural Disaster Management Law and section 188 of Myanmar's Penal Code, which carried up to two years of sentence [9].

It was under NLD that Myanmar was able to secure 1.5 million doses of the Covishield vaccination from India with another 30 million already ordered, just a week before the military takeover [16]. However, rather than the initially projected 30 million doses of Covishield, Myanmar was only able to secure 3.5 million. Further, according to data provided by the junta, as of April 2021, only 1.54 million individuals received their first vaccine doses with just 340,000 individuals completing their second dose within the recommended four-week period [17]. It was also reported that the regime used vaccination to recruit more civil servants to replace the CDM-ers [9] as citizens faced the choice of protection against a global pandemic by taking a second shot or protection of their ideologies against a dictatorship by refusing it. Another cause for controversy was that after initial shipment of Covishield from India, the regime started sourcing vaccinations from China instead, which alarmed locals in a country with extremely strong anti-China sentiments induced by Beijing's self-interest fuelled conduct in perpetuating the Myanmar military's takeover [17]. Doubts on the effectiveness of Sinopharm were further apprehended as it was proven to be 78% effective for those aged between 18 and 59, with actual effectiveness ranging from 50% to 84% depending on the country, as opposed to the Pfizer and Moderna vaccines which have been found to be more than 90% effective [18].

Amidst the rising urgency of the pandemic and the crippling healthcare system, Myanmar's military regime also put effort into blocking international assistance and humanitarian aid. The regime imposed "travel restrictions on humanitarian workers, blocked access roads and aid convoys, destroyed non-military supplies, attacked aid workers, and shut down telecommunications services" [19]. This obstruction of relief operations made for extremely limited access to said efforts due to the SAC's bureaucratic impediments, which resulted in the UN and other aid organizations only having at their disposal 18% of the US$109 million that was requested in response to the post-coup humanitarian crisis [19].

3 Methodology

3.1 Data Collection and Variables

The study utilized a retrospective cohort design with secondary data from Insecurity Insight [3] and Our World in Data [20] for variables related to healthcare obstruction incidents, vaccination rates, COVID-19 fatalities, new cases, and testing from 2020 to 2023. These datasets are publicly available, regularly updated, and sourced from various channels, including official sources, press releases, global media, lab reports, and confidential data from aid agencies.

Data on incidents of healthcare obstruction was sourced from Insecurity Insight's dataset [3] on attacks against Myanmar's health system, named "2016-2023 MMR Attacks on healthcare Incident Data." This dataset provided detailed information on the mode of obstruction, including arrest, assault, forceful entry of facilities, and more, with monthly updates. Information on Myanmar's vaccine uptake and other COVID-19 related data, such as fatalities, was extracted from the Our World in Data [20] database, which covers COVID-19 related data globally, including test administration, hospitalization, population density, and vaccinations.

The thesis reviewed data from 2020 to 2023, capturing pre- and post-coup periods. It analysed COVID-19 fatalities (*new_deaths_smoothed*), the dependent variable, and incidents of obstruction against healthcare (*IDT_total*), the independent variable, measured in event units. The regression models included variables for vaccination uptakes (*new_vaccinations_smoothed*), new COVID testing (*new_testings_smoothed*), and new cases (*new_cases_smoothed*), all tracked at corresponding dates in the dataset.

3.2 Research Design and Preliminary Analysis

After obtaining the datasets for analysis, both the incident data [3] and COVID-19 data [20] were reviewed. The 'date' column was transformed to datetime for merging the datasets and the COVID-19 data specific to Myanmar was filtered and extracted by location before processing.

After merging the datasets, incidents of healthcare obstruction were isolated into a dictionary named 'IDT', which included various types of incidents. A new column 'IDT_total' was created to group all obstruction incidents under a single category. Variables for 'new_cases_smoothed', 'new_deaths_smoothed', 'new_tests_smoothed', 'positive_rate', and 'new_vaccinations_smoothed', along with the newly calculated 'IDT_total' were chosen as key features for analysis with all other variables deleted from the merged dataset. Trend analysis on said key variables was visualized as follows:

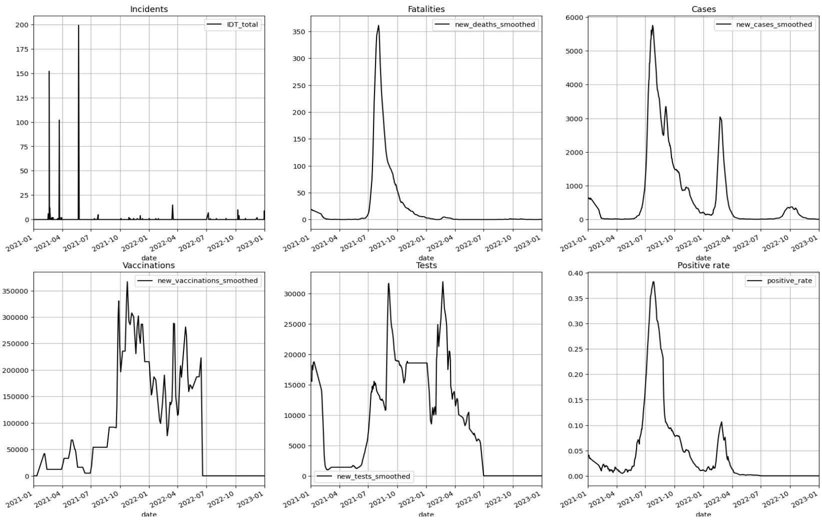

Fig. 1. Composite Subplots of Key Variables for Multivariate Regression Analysis

Figure 1 illustrates a notable surge in incidents of obstruction (*IDT_total*) immediately following the February 2021 coup, with a significant spike starting from early March 2021. This surge correlates with a stark increase in deaths observed (*new_deaths_smoothed*) around August 2021, indicating the impact of obstruction incidents (*IDT_total*) on fatalities (*new_deaths_smoothed*) and new cases (*new_cases_smoothed*). The emergence of the Omicron subvariant [21] in March 2022 led to another spike in cases *(new_cases_smoothed*), though this did not result in a corresponding increase in COVID-19 fatalities. Instead, there was a notable rise in new vaccines administered (*new_vaccinations_smoothed*) starting from October 2021, shortly after the initial wave of fatalities experienced in Myanmar. This increase in vaccinations followed a period of low vaccine uptake due to widespread distrust in the healthcare infrastructure established by the military regime [16].

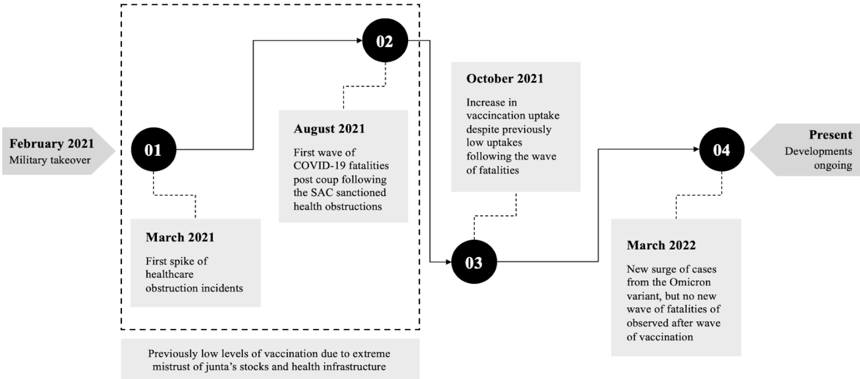

Fig. 2. Timeline Depiction of Post-Coup Impact on Health Obstruction and Public Sentiment

4 Results and Discussions

4.1 Relation between incidents of healthcare obstruction and COVID fatalities

Multivariate and autoregressive regression models were used to explore the hypothesis on healthcare obstruction incidents relative to COVID-19 fatalities incidents. The models considered vaccination rates, new testing, and new cases as covariates to ensure statistical significance. The first OLS model used COVID-19 fatalities (*new_deaths_smoothed*) as the dependent variable and total incidents of obstruction (*IDT_total*) as the independent variable.

The outcome from Model I made me consider temporal shifts due to the possibility of lagged results from healthcare obstruction, since R-Squared amounted only to 0.001, indicating little outcome reliability. The model's outcome, wherein for every new incident of health obstruction perpetrated (*IDT_total*) there would be 0.1508 less COVID-19 fatalities (*new_deaths_smoothed*), was also proven to be statistically non-significant with its p-value at 0.511.

Table 1. Testing for Model I's Heteroskedasticity and Autocorrelation

Testing for heteroskedasticity		Testing for autocorrelation	
Breusch-Pagan	0.17219416	Durbin-Watson	0.00546770
p-value	0.67816911	LM test	837.720906
f-value	0.17182029	p-value	3.39696e-184

From the results depicted in Table 1, the p-value of the Breusch-Pagan statistic or the 'BP' value for Model I, amounting to 0.678, was indicative that I'd failed to reject the null hypothesis and that there was no strong evidence of heteroscedasticity to be found in the Model. In order to further debate on said model's reliability, Model I's residuals were plotted with the Durbin-Watson and Ljung-Box (acorr_breusch_godfrey) tests conducted to test for autocorrelation, as shown in Table 1. Both results from the Durbin-Watson and the LM test suggested evidence of strong autocorrelation in the residuals of Model I with the Durbin-Watson statistic being so close to 0 at 0.005, as well as the p-value from the LM test conducted being close to 0 at 3.397e-184, indicating statistically significant autocorrelation. Accounting for this autocorrelation, autoregressive ARIMA models were considered as a next step.

Via the auto_arima function, the ARIMA order for the best fit model using residuals from Model I was established at ARIMA(order=(4, 1, 5), scoring_args={}, suppress_warnings=True, with_intercept=False), suggesting an autoregressive order of 4, differencing order of 1 and moving average order of 5 with no additional scoring arguments, warnings suppression, or intercept term. Using this ARIMA order, a series of SARIMAX models for Seasonal AutoRegressive Integrated Moving Average with eXogenous variables were performed using select key variables identified to produce the models in Table 2 as follows.

Table 2. Relation between Incidents of Healthcare Obstruction and COVID Fatalities (2020-23)

	COVID-19 fatalities			
		SARIMAX (4, 1, 5)		
	Model I	**Model II**	**Model III**	**Model IV**
Incidents of health obstruction	-0.1508 (0.299)	0.0029 (0.030)	2.494e-18*** (1.03e-24)	1.431e-17*** (3.93e-24)
Vaccination uptakes			-1.245e-19*** (2.81e-20)	-5.527e-19*** (1.27e-19)
New COVID cases				1.301e-17*** (4.07e-22)
New COVID testing				3.253e-18*** (5.03e-21)
ar.L1		0.5039*** (0.021)	0.3220*** (4.32e-22)	-0 (1.65e-22)
ar.L2		0.5004*** (0.017)	0.5058*** (3.24e-22)	-0 (1.22e-34)
ar.L3		0.6139*** (0.015)	0.3156*** (3.23e-22)	-0 (1.65e-32)
ar.L4		-0.6861*** (0.022)	-0.3179*** (2.59e-22)	-0 (1.12e-32)
ma.L1		-0.4055*** (0.025)	-0.1087*** (2.51e-22)	-0 (1.65e-22)
ma.L2		-0.3870*** (0.023)	-0.4090*** (1.48e-22)	-0 (3.25e-38)
ma.L3		-0.7299*** (0.016)	-0.3227*** (1.63e-22)	-0 (4.43e-39)
ma.L4		0.6841*** (0.018)	0.2096*** (1.15e-22)	-0 (4.45e-40)
ma.L5		0.1906*** (0.015)	0.1159*** (2.35e-22)	-0 (7.22e-39)
sigma2		9.3504*** (0.128)	1e-10*** (6.84e-11)	1e-10 (6.84e-11)
Constant	22.9781*** (2.150)			
	Variance			
R-squared	0.001			
Adjusted R-Squared	-0.001			
	Model Likelihood			
Log Likelihood	-4671.7	-2134.646	8898.629	8898.949
	Information Criterion			
AIC	9347.0	4291.291	-17771.258	-17767.898

BIC	9357.0	4343.372	-17709.708	-17696.879
Residual Analysis				
Ljing-Box Test		0.15	183.36	12.85
# of observations		842	842	842

Note. Standard errors are in parentheses. * p<0.05; ** p<0.01; *** p<0.001

Table 3. VIF Value Compilation for Models with Indication of Multicollinearity from Table 2

	Variance Inflation Factors (VIF)		
	Model II	**Model III**	**Model IV**
Incidents of health obstruction	9.29e-08	3.27e-36	2.05e-34
Vaccination uptakes		8.16e-39	3.05e-37
New COVID cases			1.69e-34
New COVID testing			1.06e-35
ar.L1	2.82e-03	5.77e-02	0.00e+00
ar.L2	2.79e-03	1.56e-01	0.00e+00
ar.L3	4.20e-03	5.53e-02	0.00e+00
ar.L4	5.25e-03	5.61e-02	0.00e+00
ma.L1	1.83e-03	6.25e-03	0.00e+00
ma.L2	1.66e-03	9.65e-02	0.00e+00
ma.L3	5.95e-03	5.80e-02	0.00e+00
ma.L4	5.22e-03	2.37e-02	0.00e+00
ma.L5	4.03e-04	7.12e-03	0.00e+00
sigma2	3.23e+01	5.26e-21	1.00e-20

Based on log likelihood alone, Model IV which include exogenous regressors on total incidents of healthcare obstructions (*IDT_total*), vaccine uptakes (*new_vaccinations_smoothed*), new COVID-19 cases (*new_cases_smoothed*) and testing (*new_tests_smoothed*) under SARIMAX (4, 1, 5) possessed the largest value, indicating best fit to the data. However, it was Model III which possessed the lowest AIC and BIC values, which provided the context of Model III actually having a better trade-off between model fit and complexity. Given that the differences in AIC and BIC between Models III and IV were calculated to be less than 1%, at 0.02% and 0.07%, respectively, it was determined that the impact of one model having better trade-off than the other was to be considered negligible. Value of the Ljung-Box test was used to assess the autocorrelation of residuals with Models III and IV having the values 183.36 and 12.85, respectively. With such a difference for this parameter, it was decided that Model IV would provide the best outcomes for interpretation with the most reliable SARIMAX model with the least amount of white noise to be considered. Since Model IV also had strong numerical indications of multicollinearity as identified from initial output, Variance Inflation Factors (“VIF”) were also accounted for. VIF ($1 / (1 - R^2)$; where R^2 was the determination coefficient obtained when the predictor variable in question was regressed against all other predictor variables in each model to determine variance of estimated regression coefficients and if they were increased due to multicollinearity. A high VIF (VIF ≥ 5) was indicative of high degrees of multicollinearity, which could make distinguishing the independent effects of correlated variables challenging, since this implied that the variances of estimated beta values were significantly inflated due to correlation with other variables. However, VIF values below 5 or above 1 (1 < VIF < 5), indicated moderate multicollinearity, which would mean some correlation, although not problematic enough to compromise interpretation reliability and no multicollinearity, meaning no correlation between the respective variables. With the VIF values of all features from Model IV being close to 0, we were able to rule out the chances of multicollinearity from the model, which was expected to have no impact on the reliability of outcome interpretation.

Hence, per results from Model IV, this paper arrived at the interpretation *that for every additional incident of healthcare obstruction, unit of new COVID-19 cases and unit of new testing recorded, there was an extremely high statistically significant pattern of increase in new COVID-19 fatalities (β = 1.431e-17***, 1.301e-17*** and 3.253e-18***) on average, while with every new unit of vaccine administered, there was an extremely high statistically significant pattern of decrease in new COVID-19 fatalities (β = -5.527e-19***) on average.* Model IV also indicated that neither past values or past forecast error terms of our dependent variable *(new_deaths_smoothed)* had any statistically significant impact on current values of COVID-19 fatalities.

4.2 Relation between incidents of healthcare obstruction and COVID fatalities based on nature of obstruction

Branching out from my initial hypothesis, regarding the relation between incidents of obstruction and COVID-19 fatalities throughout the progression of model construction, data on incidents of obstruction was isolated into separate buckets for human-related incidents and infrastructure-related incidents of healthcare obstruction.

Human-related incidents of obstruction (*IDT_human*) included figures on 'Health Workers Killed', 'Health Workers Kidnapped', 'Health Workers Arrested', 'Health Workers Injured', 'Known Kidnapping/Arrest Outcome', 'Health Workers Threatened' and 'Health Workers Sexually Assaulted', while infrastructure-related incidents of obstruction (*IDT_infra*) pertained to 'Number of Attacks on Health Facilities Reporting Destruction', 'Number of Attacks on Health Facilities Reporting Damaged', 'Forceful Entry into Health Facility', 'Occupation of Health Facility', 'Health Transportation Destroyed', 'Health Transportation Damaged', 'Health Transportation Stolen/Hijacked' and 'Looting/Theft/Robbery/Burglary of Health Supplies'.

After isolating the regressors, auto_arima was performed for human-related incidents of healthcare obstruction, establishing ARIMA(order=(4, 1, 5), scoring_args={}, suppress_warnings=True, with_intercept=False), which was the same order as established from previous models with our primary exogenous variable being IDT_total. On the other hand, infrastructure-related incidents surrounding the key variable, IDT_infra, established the ARIMA(order=(5, 1, 2), scoring_args={}, suppress_warnings=True, with_intercept=False), which stipulated an autoregressive order of 5, differencing order of 1 and moving average order of 2 with no additional scoring arguments, warnings suppression or intercept term.

Table 4. Relation between Incidents of Human-Related Healthcare Obstruction and COVID Fatalities (2020-23)

	Human-Related Incidents of Healthcare Obstruction SARIMAX (4, 1, 5)		
	Model A1	**Model A2**	**Model A3**
Incidents of health obstruction	0.0029 (0.030)	2.494e-18*** (1.03e-24)	1.431e-17*** (3.93e-24)
Vaccination uptakes		-1.245e-19*** (2.81e-20)	-5.527e-19*** (1.27e-19)
New COVID cases			1.301e-17*** (4.07e-22)
New COVID testing			3.253e-18*** (5.03e-21)
ar.L1	0.5039*** (0.021)	0.3220*** (4.32e-22)	-0 (1.65e-22)
ar.L2	0.5004*** (0.017)	0.5058*** (3.24e-22)	-0 (1.22e-34)
ar.L3	0.6139*** (0.015)	0.3156*** (3.23e-22)	-0 (1.65e-32)
ar.L4	-0.6861*** (0.022)	-0.3179*** (2.59e-22)	-0 (1.12e-32)
ma.L1	-0.4055*** (0.025)	-0.1087*** (2.51e-22)	-0 (1.65e-22)
ma.L2	-0.3870*** (0.023)	-0.4090*** (1.48e-22)	-0 (3.25e-38)
ma.L3	-0.7299*** (0.016)	-0.3227*** (1.63e-22)	-0 (4.43e-39)
ma.L4	0.6841*** (0.018)	0.2096*** (1.15e-22)	-0 (4.45e-40)
ma.L5	0.1906*** (0.015)	0.1159*** (2.35e-22)	-0 (7.22e-39)
sigma2	9.3504*** (0.128)	1e-10*** (6.84e-11)	1e-10 (6.84e-11)
	Model Likelihood		
Log Likelihood	-2134.646	8898.629	8898.949
	Information Criterion		
AIC	4291.291	-17771.258	-17767.898
BIC	4343.372	-17709.708	-17696.879
	Residual Analysis		
Ljung-Box Test	0.15	183.36	12.85
# of observations	842	842	842

Note. Standard errors are in parentheses. * p<0.05; ** p<0.01; *** p<0.001

Table 5. VIF Value Compilation for Models with Indication of Multicollinearity from Table 4

	Variance Inflation Factors (VIF)		
	Model A1	**Model A2**	**Model A3**
Incidents of health obstruction	9.29e-08	3.27e-36	2.05e-34
Vaccination uptakes		8.16e-39	3.05e-37
New COVID cases			1.69e-34
New COVID testing			1.06eE-35
ar.L1	2.82e-03	5.77e-02	0.00e+00
ar.L2	2.79e-03	1.56e-01	0.00e+00
ar.L3	4.20e-03	5.53e-02	0.00e+00
ar.L4	5.25e-03	5.61e-02	0.00e+00
ma.L1	1.83e-03	6.25e-03	0.00e+00
ma.L2	1.66e-03	9.65e-02	0.00e+00
ma.L3	5.95e-03	5.80e-02	0.00e+00
ma.L4	5.22e-03	2.37e-02	0.00e+00
ma.L5	4.03e-04	7.12e-03	0.00e+00
sigma2	3.23e+01	5.26e-21	1.00e-20

Table 6. Relation between Incidents of Infrastructure-Related Healthcare Obstruction and COVID Fatalities (2020-23)

	Infrastructure-Related Incidents of Healthcare Obstruction SARIMAX (5, 1, 2)		
	Model B1	**Model B2**	**Model B3**
Incidents of health obstruction	-2.362e-08 (2.34e-08)	-5.294e-23 (0)	4.698e-21 (6.73e-06)
Vaccination uptakes		3.388e-21 (9.76e-10)	-3.74e-19 (0.002)
New COVID cases			-6.765e-17 (8.02e-06)
New COVID testing			2.06e-18 (4.64e-05)
ar.L1	0.1273*** (0.041)	0.1122*** (4.58e-10)	-0 (1.95e-09)
ar.L2	0.2071*** (0.038)	0.3848*** (3.1e-10)	-0 (6.13e-08)
ar.L3	0.1153*** (0.016)	0.0701*** (3.33e-10)	-0 (4.84e-09)
ar.L4	0.0421** (0.015)	-0.0025***(2.83e-10)	-0 (5.2e-08)
ar.L5	0.3451*** (0.013)	0.3235*** (4.24e-10)	0 (6.65e-09)
ma.L1	0.014 (0.041)	-0.0032*** (2.03e-10)	-0.0695*** (1.21e-07)
ma.L2	-0.0524 (0.036)	-0.2201*** (3.61e-11)	-0.8661*** (2.67e-07)
sigma2	9.6391*** (0.103)	1e-10 (6.85e-11)	1e-10 (7.32e-11)
	Model Likelihood		
Log Likelihood	-2177.151	8898.567	8907.773

	Information Criterion		
AIC	4372.301	-17775.134	-17789.546
BIC	4414.913	-17723.054	-17727.996
	Residual Analysis		
Ljung-Box Test	0.00	10.53	291.43
# of observations	842	842	842

Note. Standard errors are in parentheses. * p<0.05; ** p<0.01; *** p<0.001

Table 7. VIF Value Compilation for Models with Indication of Multicollinearity from Table 6

	Variance Inflation Factors (VIF)		
	Model A1	**Model A2**	**Model A3**
Incidents of health obstruction	5.99e-18	2.13e-45	1.26e-41
Vaccination uptakes		8.71e-42	7.97e-38
New COVID cases			2.61e-33
New COVID testing			2.42e-36
ar.L1	1.74e-04	9.64e-03	0.00e+00
ar.L2	4.61e-04	1.27e-01	0.00e+00
ar.L3	1.43e-04	3.74e-03	0.00e+00
ar.L4	1.90e-05	4.82e-06	0.00e+00
ar.L5	1.28e-03	8.62e-02	0.00e+00
ma.L1	2.10e-06	7.55e-06	2.76e-03
ma.L2	2.95e-05	3.81e-02	7.46e-01
sigma2	4.74e+02	7.58e-21	5.70e-21

Since none of the coefficients in Model B1 to B3, regressed against infrastructure-related incidents of healthcare obstruction (*IDT_infra*) depicted any statistical significance for our selected key variables, it was established that COVID-19 fatalities driven by total incidents of health obstruction were mostly propelled by human-related incidents of healthcare obstruction. In fact, the coefficients, and related statistics between Models II to IV and Models A1 to A3 were found to be near identical. As such, with Model A3 possessing the highest log likelihood value, as well as a lower Ljung-Box statistic with similar AIC and BIC by an almost negligible margin, between Models A2 and A3, it was determined that Model A3 was best representative of the relation between COVID-19 fatalities and human-related incidents of healthcare obstruction. Further, with VIF values of all predictors from the model being close to 0, we were able to rule chances of multicollinearity out of the model - expected to have no impact on the reliability of outcome interpretation.

Given this, Model A3 arrived at the same conclusions as Model IV, wherein with every additional incident of healthcare obstruction, unit of new COVID-19 case and unit of new testing recorded, there was an *extremely high statistically significant pattern of increase in new COVID-19 fatalities (β = 1.431e-17***, 1.301e-17*** and 3.253e-18***) on average, while with every new unit of vaccine administered, there* *was an extremely high statistically significant pattern of decrease in new COVID-19 fatalities (β = -5.527e-19***) on average,* along with proof that neither past values nor past forecast error terms of our dependent variable *(new_deaths_smoothed)* had any statistically significant impact on current values of COVID-19 fatalities.

With respect to relation between COVID-19 fatalities and infrastructure-related incidents of healthcare obstruction, all models conducted in exploring this had consistent outcomes wherein there was no association to be found between said values, which reaffirmed that the COVID-19 fatalities were mostly, if not solely, contributed by human-related incidents of obstruction. In terms of which model had the most reliable outcome, among Models B1 to B3, Model B3 ran using SARIMAX (5, 1, 2) determined via auto_arima, possessed both the highest value of log likelihood, as well as the lowest values of AIC and BIC, which denoted that Model B3 had the best fit data, as well as the best trade-off between data fit and model complexity. However, out of the three options, it also possessed the highest Ljung-Box test statistic, which implied that Model B3 had strong indications of autocorrelation. Regardless, this paper determined Model B3 to be the most reliable in the interpretability of findings on account of prioritizing model fit and complexity as opposed to autocorrelation of residuals.

5 Conclusion

When Myanmar descended into dictatorship in February 2021, the military doubled down on its crackdown, with COVID-19 as backdrop, attacking the very core of an already crippling health system, resultantly overrunning mortuaries (Reuters 2021), in order to distract the public from taking to the streets using a public health crisis. Implications of COVID-19, compounded by the striking CDM health workers, along with the military's active interference of working health personnel, the country's pandemic response, along with its healthcare infrastructure systematically collapsed in on itself, resulting in rising COVID-19 fatalities (Rocha et al., 2021). This paper explored the impacts that obstructing the healthcare system had on COVID-19 fatalities, in the context of Myanmar, for the period 2020-2023.

> **Hypothesis:** The variable for incidents of obstruction against healthcare (IDT_total) has a positive lagged association with the variables for COVID-19 fatalities (new_deaths_smoothed) and vaccination uptakes (new_vaccinations_smoothed), as well as new COVID testing (new_tests_smoothed) and cases (new_cases_smoothed), respectively.

The study confirmed a direct correlation between healthcare obstruction incidents and COVID-19 fatalities, with each obstructive event contributing to an increase in the death toll. It was noted additionally that human-related obstruction events had a more significant impact on COVID-19 fatalities and new case reporting, while infrastructure-related incidents had minimal influence on these variables.

5.1 Incidents of Healthcare Obstruction and COVID-19 Fatalities

The hypothesis of this research indicated that the dependent variable for COVID-19 fatalities had positive lagged association with the variables for incidents of healthcare obstruction, as well as new COVID testing and cases, whereas a negative lagged association was observed with uptake of vaccinations relative to new fatalities. This was proven to be true as we were able to establish relation between incidents of healthcare obstruction and COVID-19 fatalities, wherein *for every new incident of healthcare obstruction, new COVID-19 case and new testing, there were 1.431e-17, 1.301e-17 and 3.253e-18 more COVID-19 fatalities, on average, respectively, with this outcome having extremely high statistical significance (p-value = 0.000).* The research was able to provide further insight that *for every new incident of healthcare obstruction that occurs, there was also a -5.527e-19 decrease in new vaccines administered, on average, with said insight also being found to be of extremely high statistical significance (p-value = 0.000).*

5.2 Incidents of Healthcare Obstruction and COVID-19 Fatalities based on Nature of Obstruction

Branching from analysing incidents of healthcare obstruction as a whole, under the collective banner of exploring our first hypothesis, this study isolated the data into two buckets, under human- and infrastructure-related events of health obstruction. It was found that much of the impact on fatalities observed earlier in the analysis, as well as the new cases recorded, were driven by human-related incidents of obstruction as all outcomes remained constant among the models featuring total and human-related incidents, respectively, whereas infrastructure-related incidents did not appear to have any implications toward any of the featured exogenous variables. The data on healthcare obstruction and COVID-related information may not capture the full extent of events due to under-reporting and challenges in data collection during ongoing conflict. However, this research serves as a foundation for future studies and informs international policies on disease weaponization and bio-warfare regulation.

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