

## THE IMPACT OF COVID IN HIGHER EDUCATION

## COVID-19 and university admission exams: A Bangladesh perspective

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**Abstract**

*Background:* Educational institutions have been closed in Bangladesh due to the COVID-19 pandemic, and board exams like Higher Secondary Certificate (HSC) exams, as well as university admission exams have been suspended. Secondary school students have been promoted based on past performance. As the time has come for students to take admission into universities, educational authorities must make decisions about the logistical and public health arrangements that could allow universities to conduct admission exams.

*Design and methods:* The public health and lockdown policies were analyzed during the timeframe of 25<sup>th</sup> March to 15<sup>th</sup> October. Time series models of the trend of COVID-19 were prepared for the near future using the ARIMA technique, for the lockdown phase and the post lockdown phase. This was evaluated in juxtaposition with the restrictions relating to travel, work, schools, public gatherings, face masks etc. The models were then used to forecast positivity rates for two weeks into the future.

*Results:* The curve was not bent during the strict lockdown phase, but the post lockdown phase eventually saw a decline in positivity rates. The best models selected were ARIMA(0,1,7) for the lockdown stage, and ARIMA(7,1,0) for the post lockdown stage. AIC, BIC, RMSE, MAE, and MAPE criteria were used for model selection.

*Conclusions:* Many restrictions of the lockdown phase have been continued until the present time, and disease case positivity rates have declined. However, the resumption of work and domestic travel has not prevented the control of the spread of the disease. It may therefore be possible to conduct in person admission test exams for universities, while maintaining social distancing, face masks and other public health measures.

**Introduction**

The COVID-19 virus has been responsible for the current pandemic in the world in 2020. It has been discovered to be a strain

of the corona virus, and was designated as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).<sup>1</sup> The transmission of the virus is primarily airborne through respiratory droplets; infection through indirect contact i.e. when someone is exposed to the environment or objects that an infected person has come into contact with is also possible.<sup>2</sup>

The first case of COVID-19 was detected in December 2019 in Wuhan China, and the outbreak of COVID-19 cases seen in China was declared to be a case of Public Health Emergency of International Concern. It rapidly spread from China to the rest of the world and on 11<sup>th</sup> March, 2020 COVID-19 was declared to be a pandemic.<sup>3</sup> The highly contagious nature of the disease has necessitated the imposition of social distancing measures in all walks of life, including the education sector. From April 2020, 185 countries of the world closed their schools and higher education institutions, affecting around 90% of learners around the world.<sup>4</sup> Campuses were closed and classrooms learning was replaced by distance learning platforms. However, this has proved to be an incomplete solution, as in middle- and low-income countries, distance learning reaches only 62% of students through television, and 24% through online delivery, leaving hundreds of millions of students without educational access.<sup>5</sup>

The first case of COVID-19 was diagnosed on 8<sup>th</sup> March in Bangladesh and the number of cases climbed to 33 by 23<sup>rd</sup> March, 2020. Under the circumstances, the Government of Bangladesh imposed a country-wide extensive lockdown of government offices, non-government offices, factories, public transport, markets *etc.* from 26<sup>th</sup> March 2020, for an initial duration of 10 days. Educational institutions closed even before the lockdown, from the 17<sup>th</sup> March 2020. Students vacated dormitories and went back to their homes. Public transport system also came to a halt and to enforce social distancing, law-enforcing agencies including the army, police and other security forces were deployed.<sup>6</sup> However, provisions were kept in the government circular to continue the emergency services including healthcare services, and duties performed by the law-enforcement agencies were out of the purview of the shutdown.<sup>7</sup> Meanwhile, an estimated population of over eleven million people moved from Dhaka to their respective home districts. Two weeks into the lockdown, there was a movement of

**Significance for public health**

*The outbreak of the COVID-19 pandemic has disrupted educational activities worldwide, moved classes to the online platform, and delayed exams, graduations and admissions. Bangladesh has one of the most conservative and risk averse policies when it comes to opening educational institutions during the pandemic. However, a prolonged and indefinite delay in allowing essential milestones like university admission exams can hamper the progress and competitiveness of millions of Bangladeshi students in their careers. If the spread of the disease is not increasing in the near future, it can be possible to organize university admission tests with proper health and safety arrangements, to enable students to continue their higher education journey. This study makes short term predictions of the progression of COVID-19 in Bangladesh, using ARIMA models, to advise educational authorities about policy and logistical measures to enable this journey.*

the ready-made garments industry workers to the industrial districts. An initial lack of community awareness among people led to the further nation-wide spread of the disease.<sup>7</sup> This initial lockdown, in the form of a general holiday, was extended several times, until there was an announcement from the Government that the lockdown would end and people would be able to resume work and travel from 31<sup>st</sup> May, 2020. However, the closure of the schools and colleges was continued even after the lift of the lockdown, and social distancing measures were still put in place albeit, with some relaxation. There were exemptions for the vulnerable population such as pregnant women, the elderly, and patients with multiple chronic diseases, from resumption of joining into their workplace.<sup>6</sup> In order to assess risks, to identify the level of response and to facilitate planning, the Government of Bangladesh (Directorate General of Health services (DGHS) and the Institute of Epidemiology, Disease Control and Research (IEDCR)) formulated the “National Preparedness and Response Plan for COVID-19, Bangladesh” and published it on 5<sup>th</sup> March 2020.<sup>8</sup> As some vital restrictions of the lockdown are still in place, like the closure of educational institutions, this has posed serious challenges for the progress of education of students in important milestones in their career. For example, the higher secondary certificate exams (HSC) were not held in 2020, and it was decided that the students would apply for university admission based on secondary school (Secondary School Certificate) and eighth grade (Junior School Certificate) scores. The university admission exams have also not been held yet. In Bangladesh, there are 34 public universities with a capacity for 264,084 students. Colleges under the National University and Open University can accommodate another 2,300,053 students. Technical institutes have seats for 89,723 students and private universities have a capacity for 337,157 students.<sup>9</sup> Therefore, the academic careers of many students are now in a state of uncertainty, as they had no clear guidelines about their next step towards higher education. It has been almost ten months since the suspension of physical classes, though classes have continued online. However, online conduction of critical examinations such as university admission tests are considered unreliable. Moreover, usually students apply for admission in a number of universities and choose the best option. This entails travelling to different cities to attend admission tests. There is competition among universities for students, and competition among students for the best universities. Therefore, there are ongoing heated deliberations about relaxing the restrictions to allow students to take university admission tests to continue their higher education.<sup>10</sup> If guidelines are not issued in due time, students risk falling behind in the academic timeline.

In this context, the purpose of this research is to make short term forecasts of the positivity rates of COVID-19 in Bangladesh during and after the lockdown phase, using the Autoregressive Integrated Moving Average (ARIMA) technique, and relate the changes of the positivity rates to the public health restrictions prevalent at the time. The authors of this study believe that such predictions are necessary in order to shed light on the risks of a temporary or partial relaxation of the rules of public gatherings and travel that university admission exams would entail. It is also necessary to prepare public health authorities to take necessary measures, such as increasing hospital staff and the number of COVID-19 isolation wards, and procuring necessary medical equipment like ventilators, in case any increases in cases occur as a result of some public gathering events. These forecasts would also greatly aid in estimating the measures needed for university administrators to make seating arrangements and identify exam centers throughout the country.

Currently, countries around the world are experiencing the

pandemic without strict lockdown measures. Bangladesh, itself is now experiencing a period of more lax measures since 31<sup>st</sup> May 2020. At present, the main restriction still to be continued as before has been the closing of educational institutes, and there are plans for extension of the close.<sup>11</sup> The study aims to understand how the infection spreads in the presence and absence of strict lockdown measures, in the context of Bangladesh, and provide some insights about the advisability of conducting in person university exams.

## Literature review

### *Adaptation strategies in higher education in times of COVID-19*

The COVID-19 pandemic has brought about widespread changes in the lives of students across the world, and posed numerous logistic, emotional and psychological challenges to continuing education in such unusual circumstances. A study by Aristovnik *et al.*,<sup>12</sup> covering over 30,000 students in 62 countries, has showed that the students who are isolated in homes and dependent on distance online learning suffer concerns and uncertainty about their future professional careers, and felt boredom, anxiety and frustration. Sundarasan *et al.*<sup>13</sup> have found that students in Malaysia experience various degrees of anxiety during the COVID-19 lockdown, caused by financial constraints, online teaching and uncertainty with regards to their academic performance and career prospects. A study on coping strategies in students in China, by Nurunnabi *et al.*,<sup>14</sup> showed that students employed coping strategies like seeking social support, avoidance, mental disengagement and humanitarian methods, where higher levels of anxiety led to the more frequent use of coping strategies. Panovska-Griffiths *et al.*<sup>15</sup> performed a modelling study for the optimal strategy for reopening schools and estimated that between 59% and 87% of positive cases should be tested and detected for isolation, in partial to full reopening scenarios, in order to prevent a second wave. Ziauddeen *et al.*<sup>16</sup> have analysed the pros and cons of reopening schools in the UK, and have concluded that some students suffer from significant disadvantages including food shortages, and that reopening schools would be beneficial for many children and their families, while bringing risks to families with vulnerable adults. D’angelo *et al.*<sup>17</sup> have performed a scoping review of studies on school reopening and lockdown exit strategies, covering multiple countries. They have identified a number of recommended conditions and strategies, including reopening during low infection rates, strict infection thresholds for reclosing of schools, reducing class sizes, differentiating shifts, staggered reopening, and practicing general hygiene measures like face masks, social distancing, hand washing, *etc.* Leung and Wu<sup>18</sup> argue that relaxation of lockdowns and reopening schools should follow a thorough knowledge of local transmission levels, and there should be gradual release exit strategies, tailored to the local situation. Viner *et al.*<sup>19</sup> argue that the harms to school closing are greater in lower- and middle-income countries, arising from lack of school meals and medical support, increase in school dropouts, child marriages and child labour. To mitigate this, they advise cautious school reopening, splitting up classes into small groups, staggering school times, and protecting vulnerable students and teachers. Han *et al.*<sup>20</sup> review strategies of easing lockdown restrictions in Europe and the Asia Pacific and find that strategies include having threshold criteria for the transmission rate (R), trigger-based approaches and weekly positivity rates, and opening conditions include wearing of facemasks and social distancing.

### **Public health response to COVID-19 in Bangladesh**

In this section, we review the government and public health measures to COVID-19 during the lockdown and post lockdown

period in Bangladesh. We look at key indicators of response, including government stringency measures, containment and health measures, and economic support to maintain the lockdown. The data is compiled from the Blavatnik School of Government, University of Oxford.<sup>21</sup> We compare the overall government response stringency index of Bangladesh with that of a number of regional and global governments including China, India, and Pakistan. We next make a comparison of the risk of opening during this time period and relate it to the response stringency. The risk of opening index is based on criteria including the extent of control of transmission, testing and tracing, managing the risk of imported

cases, community engagement and understanding and an endemic factor measuring the extent of new cases. This data is compiled from the Blavatnik School of Government, University of Oxford.<sup>22</sup>

From the trend of stringency of response (Figure 1a), we can see that the measures were quite strictly imposed during the lockdown period in Bangladesh, but when the lockdown was lifted, there was a relaxation of the rules for a couple of weeks. However, stringency levels were once again increased, although with qualitative differences. According to the risk of opening index (Figure 1b), the risk of opening remains high, even though the actual positivity rate is falling over the post lockdown period (Figure 2). In

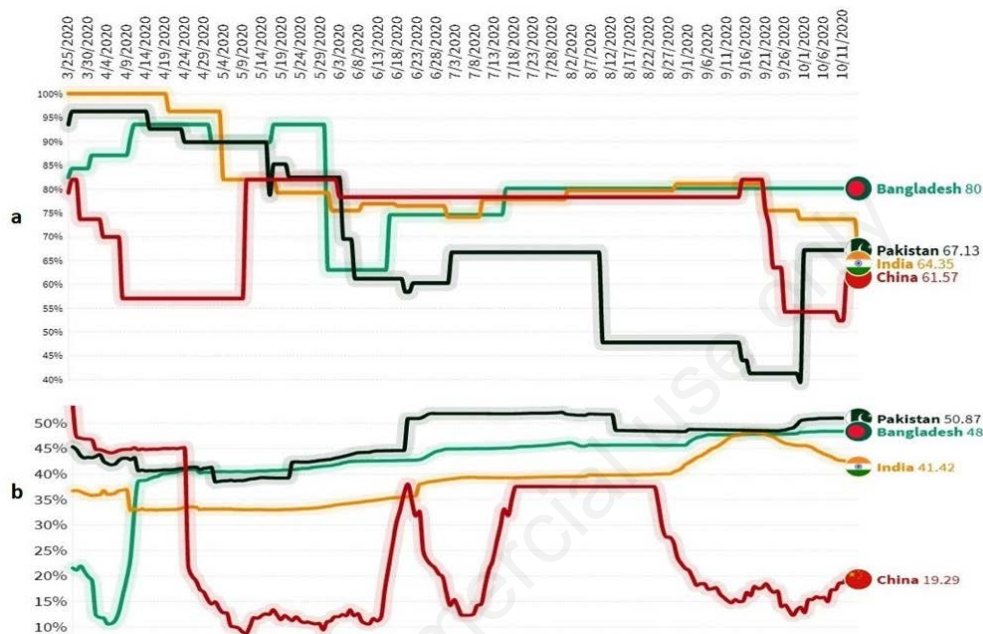


Figure 1. a) Comparison and trend of index of stringency of response to COVID-19. b) Comparison and trend of risk of opening index.

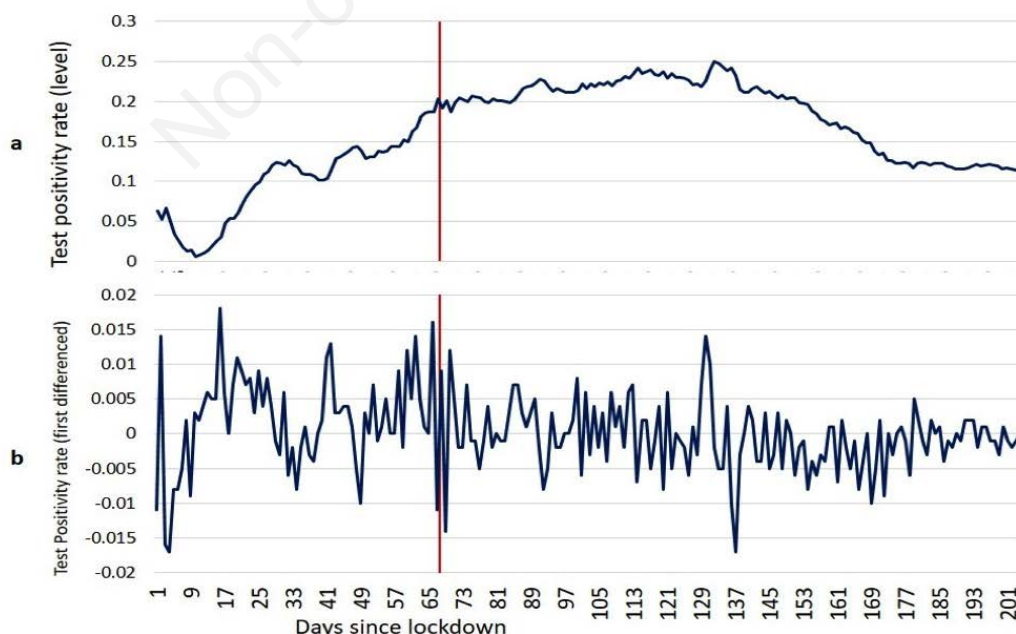


Figure 2. Trend of the positivity rate (a) at level and (b) at first difference over the time period from 26<sup>th</sup> March to 15<sup>th</sup> October, 2020. The red vertical line shows the demarcation between the strict lockdown and post lockdown period.



consideration of the risks, Bangladesh has continued the stringent public health measures, even after the neighbouring countries in the region relaxed their own measures following the lockdown period. Meanwhile, universities across Asia have been opening cautiously and admission exams have been announced and conducted in the neighbouring countries.<sup>23</sup> Governments of neighbouring countries have also relaxed rules to allow continuation of academic activities in these countries.<sup>21</sup>

The timelines of the lockdown policies are given in Figure 3. We can see that some of the measures were continued, like the prevention of public gatherings, and the work from home policies for many organizations. There was the Eid-ul-Adha festival on the 1<sup>st</sup> of August, when people from the cities went to their rural hometowns to visit their families for the holidays. However, here too, people were restricted to small family gatherings, and large public assemblies were avoided. Bangladesh has a policy of testing anyone with symptoms, and conducts coordinated public information campaigns across traditional and social media about the disease. Contract tracing is limited to some cases. There is a general stay at home recommendation, but is currently not actively enforced, though it was enforced by law-enforcement authorities during the lockdown stage.<sup>21</sup>

## Design and Methods

The ARIMA model has been used before in Bangladesh to forecast endemic diseases. A variant of the ARIMA model, the Seasonal Autoregressive Integrated Moving Average Model, or SARIMA, was used to forecast the incidence of Dengue in Bangladesh.<sup>24</sup> The ARIMA model itself was used to compare differences in dengue incidences in Bangladesh from two different time periods.<sup>25</sup> While other methods such as CUBIST<sup>26</sup> and arti-

cial neural network<sup>27</sup> have been used in the past, we agreed that the ARIMA model would be the best for this study. This model has been widely and commonly used and has often found to be the most reliable with regards to accuracy in many previous studies.<sup>28,29</sup> Of course, while ARIMA has shown success with regards to many of the studies cited, it cannot accurately predict the outcomes in the possibility of medical breakthroughs like a vaccine.<sup>30</sup>

Ceylan,<sup>28</sup> Kirbaş *et al.*<sup>27</sup> and Singh *et al.*<sup>29</sup> use ARIMA models to forecast cases in a number of European countries during the beginning of the pandemic. Multi country forecasts for high-risk countries were made by Sahai *et al.*<sup>30</sup> and Singh *et al.*<sup>31</sup> They covered a time period in the early and mid-stage of the pandemic. Since then, countries have gone through a post lockdown period, and many countries are experiencing a second wave. There have also been a number of single country studies. Singh *et al.*<sup>29</sup> predicted the number of cases in Malaysia at the beginning of the pandemic. Ribeiro *et al.*<sup>26</sup> forecasted cases in Brazil and found that six days forecasts were the most accurate. Chintalapudi *et al.*<sup>32</sup> made forecasts for number of cases and recoveries in Italy with over 84% accuracy. Yang *et al.*<sup>33</sup> made forecasts for new cases and new deaths in Italy and found their models effective for short terms predictions. The ARIMA model has also been used to forecast COVID-19 cases for the purpose of making decisions about important public events. For example, Alzahrani *et al.*<sup>34</sup> have made forecasts for new cases and cumulative cases in Saudi Arabia and showed that it would be best to suspend the annual Umrah and Hajj Pilgrimages to the holy cities of Mecca and Medina, due to the extreme public health risks.

Our review has revealed some gaps in the use of forecasting models to predict the novel coronavirus COVID-19. For example, a risk of using ARIMA to make long term forecasts is that the forecasts can be premature.<sup>35</sup> The forecasting of cases several months into the future tends to significantly under or overestimate the

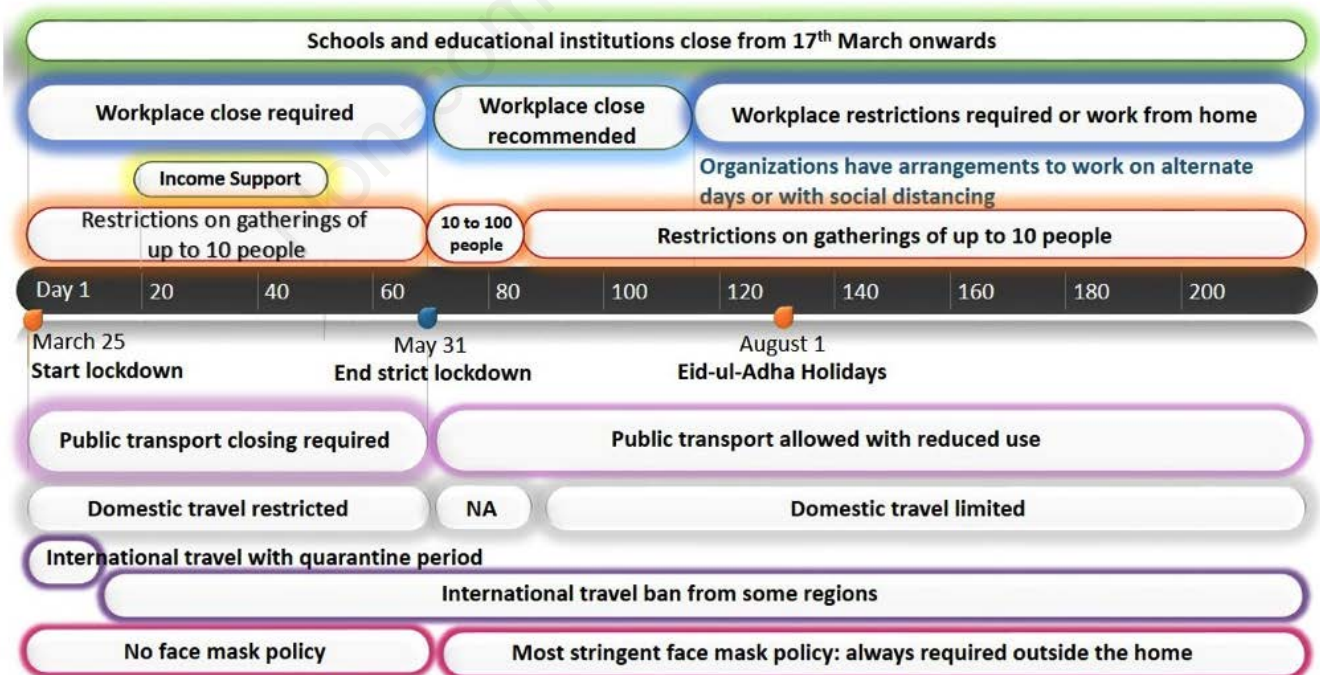


Figure 3. Timeline of lockdown policies and measures in the study period.

number of cases. Moreover, ARIMA is not suitable for predicting inflexion points, and cannot predict the point where countries bend the curve or are on the verge of a second wave. To account for this, we divide our data into two periods, the during-lockdown and the post-lockdown period. Our literature review also reveals that the forecast models are not discussed in the context of the prevalent lockdown policies. Only Katris<sup>36</sup> mentions the strictness of the policy response in a number of European countries and compares the correlation of the stringency with different transmission data, using Spearman correlation. This study found that there was no significant correlation between the stringency of measures and the outcome of the disease transmission. However, the study did not specify any lag period for the policy measures to take effect, and a static stringency measure on a particular date was used, whereas the progression of the pandemic is dynamic. It did not consider the nuances of information, the qualitative basis of the stringency index, and the time lag between lockdown policies and a change in transmission. To explore this area, in this study, we will inspect the qualitative effects of lockdown measures on disease transmission and consider the ongoing effects of past measures.

ARIMA models are a common forecast model in the studies and provide a benchmark and basis for comparison. We have accordingly based our forecast models on the ARIMA technique.

### Data preparation

The data for the number of tests conducted and the number of cases confirmed daily were obtained from the website of the Director General of Health Services (DGHS), Ministry of Health and Family Welfare (MOH&FW),<sup>37</sup> where the statistics of COVID-19 are published on a daily basis. The time period considered is divided into two parts. The first phase is the strict lockdown phase, lasting from 26<sup>th</sup> March to 30<sup>th</sup> May 2020. The second phase is when the lockdown was lifted and public movements and activities resumed, albeit with personal precautions like wearing mask and social distancing. This phase started from 31<sup>st</sup> May and continues to the time of this writing. We take the time period from 1<sup>st</sup> June to 15<sup>th</sup> October to represent the second phase. Our review shows that most ARIMA studies on COVID-19 use daily numbers of detected infections, or cumulative numbers of infections. However, we have used the case positivity rate per day to represent the incidence and spread of COVID-19 infections in the population. If the positivity rate is high, it implies that that community may be mainly testing the most ill patients while missing patients with no symptoms or milder symptoms. The daily positivity rate is obtained by dividing the number of positive tests by the total number of tests conducted that day. This method gives a proxy of the rate of transmission of the disease at a particular time, even though the total number of actual cases cannot be measured because of testing limitations. The existing literature we have reviewed used the number of confirmed cases to represent the incidence of COVID-19 infections in the population, but previous literature on infection rates have often used the positivity rates, which are standardized according to the level of testing. For example, He and Tao<sup>38</sup> have used the ARIMA method to predict the positive rate of different strains of influenza viruses occurring in Wuhan, China, using data collected from sample hospitals. The advantage of using a rate rather than an absolute number allows for variations in testing across time. We also use the seven-day moving average of the positivity rate, in order to smooth out the effects of irregularities due to weekends and holidays.

### Time series analysis

As an empirical model we are using the autoregressive inte-

grated moving average (ARIMA) method developed by Box *et al.*<sup>39</sup> This technique allows the modelling of time series data. The general multiplicative ARIMA model can be summarized as

$$ARIMA(pdq) \tag{eq. 1}$$

where  $p$  and  $q$  are the autoregressive and moving average lag orders, and  $d$  is the order of differencing.

$$Y_t = (1 - B)^d X_t \tag{eq. 2}$$

where  $B$  is the backward operator to indicate differencing, ie,  $B(Y_t) = (Y_t - Y_{t-1})$ . The model can be expressed as

$$Y_t = \sum_{i=1}^p \phi_i Y_{t-i} + \sum_{j=1}^q \theta_j u_{t-j} \tag{eq. 3}$$

where  $\phi$  and  $\theta$  are the autoregressive and moving average parameters respectively.  $Y_t$  is the observed value of the time series variable at time  $t$ . As the disease has been prevalent for less than a year, we do not have enough data to model seasonal patterns. The best model can be chosen from a number of prospective models based on the Akaike Information Criteria (AIC), Bays Information Criteria (BIC), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE) and Mean Absolute Error (MAE). Lower values of these measures indicate better fit of the data. RMSE, MAE and MAPE can be expressed mathematically in eqs. 4, 5 and 6:

$$RMSE = \sqrt{\frac{1}{n} \sum_{t=1}^n e_t^2} \tag{eq. 4}$$

$$MAE = \frac{1}{n} \sum_{t=1}^n |e_t| \tag{eq. 5}$$

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{e_t}{y_t} \right| \tag{eq. 6}$$

There four key steps to conducting ARIMA modelling, identification, estimation, diagnosis and forecasting. We use dSPSS 16 and EViews 9 statistical software to prepare and run the models. The steps can be elaborated as follows:

1. The time series data is first checked for stationarity. We do this by visual inspection and by using the Augmented Dickey-Fuller (ADF) test. The null hypothesis of this test is that there is unit root, i.e., the data is not stationary. If this is rejected, it means that the data is stationary. Non-stationary data can be made stationary through differencing.
2. After the time series is made stationary, the correlogram is inspected to prepare the identification of the model. The correlogram of the autocorrelation function (ACF) can be used to determine the moving average (MA) order, and the correlogram of the partial autocorrelation function (PACF) is used to detect the autocorrelation (AR) order.
3. The ARIMA model is estimated based on the  $p$ ,  $d$  and  $q$  terms. If more than one possible model seems possible, the different prospective models are estimated, and the best one is chosen based on the Akaike Information Criteria (AIC), Bays Information Criteria (BIC), RMSE, MAPE and MAE.
4. The residual analysis is done as a diagnostic. All the lags should be within the 95% confidence interval in the correlo-

- grams of the residuals.
- The chosen model can be used to forecast for the following two weeks.

## Results

In the first step, we check the trend of the data graphically in order to determine if the data is stationary. Figure 2 shows the graph for the two periods. We can see that the time series is not stationary in either period (Figure 3), and has an increasing followed by a decreasing trend. The trend is increasing in the first phase during the lockdown, but the trend after the lockdown is lifted first increases at a slower rate, then remains the same for a few days, and then starts to decline rapidly before again reaching a stable rate. The correlogram of the level data for the two phases also reveals that it is not stationary (Figure 4 a,b). Therefore, to make the data stationary, we difference it. The first differenced data is shown in Figure 2b. This now has a stationary pattern. The correlograms of the first differenced data for the two phases also reveals that it has become stationary (Figure 4 c,d). We confirm this by conducting the ADF test. The ADF test is rejected at the 1% level of significance. From the correlogram of the first differenced data during the lockdown period, we can see that there is an initial decay in the correlations, but there is a significant correlation in the second lag in the ACF and the PACF. Moreover, there is a significant correlation in the 7<sup>th</sup> lag in the PACF. Therefore, we will compare a number of models including ARIMA(2,1,0), ARIMA(0,1,2), ARIMA(7,1,0), and ARIMA(0,1,7). From the correlogram of the first differenced data from the post lockdown period, we can see that there is a significant correlation for both the ACF and PACF at the seventh lag. Therefore, we will test two different ARIMA models for this period, ie, ARIMA (7,1,0) and ARIMA (0,1,7). The results of the models are in Table 1. The best model is chosen in each case based on the AIC and other criteria. In the model for the

lockdown phase, the AIC and MAPE values prefer the model ARIMA(0,1,7). For the post lockdown stage, the AIC and BIC indicate the model ARIMA(7,1,0). The MAE and RMSE are tied. Therefore, for the lockdown stage, we have chosen ARIMA (0,1,7), and for the post lockdown period, we have chosen the model ARIMA(7,1,0).

## Diagnostics

We have performed the diagnostics of the models by inspecting the correlograms of the residuals. We found that the ACF and PACF are approximately within the 95% confidence interval, and there are no prominent correlations on the lags.

## Forecast

We use the chosen models to forecast for the following two weeks (Figure 5). From the forecast graph, we can see that there is a good fit between the actual observed values, the fitted values and the forecast values. During the lockdown period, the forecast was that the trend of positivity would continue upwards, as it did for around six weeks. However, towards the end of our study period, the trend was decreasing, and the forecast has predicted a continued decrease of the positivity rate for the near future.

## Discussion

Our analysis has shown that the trend of the disease transmission of COVID-19 continued to rise at a slow rate even after approximately ten weeks of strict lockdowns, where public movements and activities were strictly regulated. However, the strictest levels of restrictions are not viable in terms of normal activities, and the government ultimately relaxed the lockdown rules to allow work and business to resume. Non-essential businesses and markets were reopened, and people resumed their work under the new normal. However, in order to compensate for this flexibility, a new

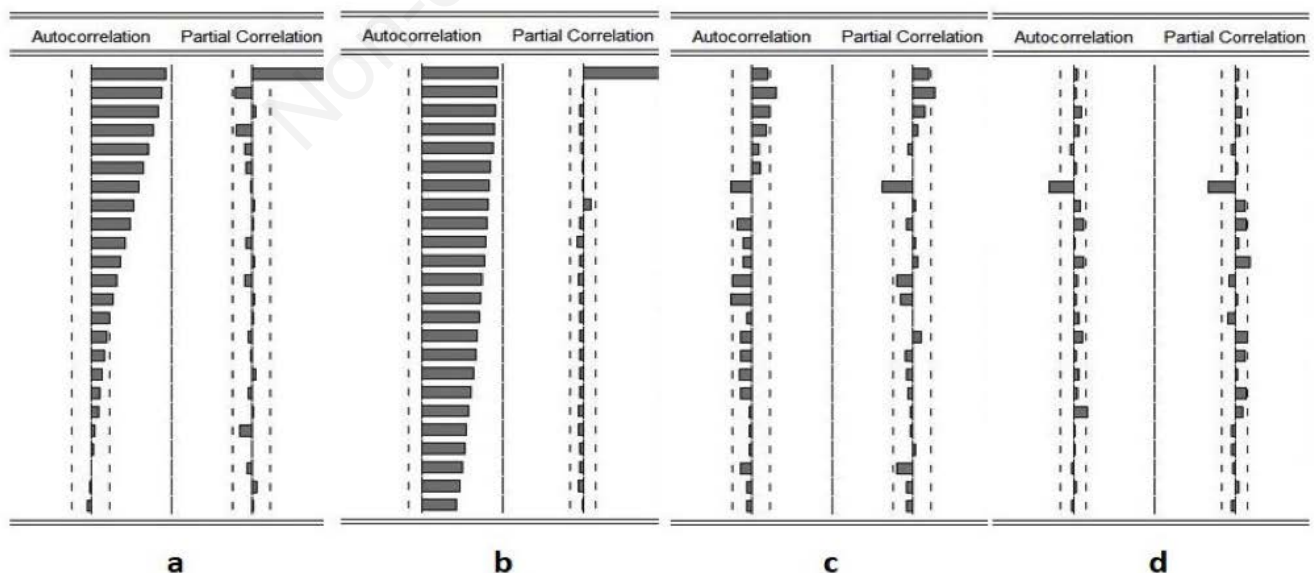


Figure 4. Correlograms of positivity rates (a) level data during lockdown; (b) level data after lockdown; (c) first differenced data during lockdown and (d) first differenced data after lockdown.



rule of strict mask wearing was instituted and commonly followed by the public. Moreover, the restrictions against public gatherings continued to be in place. This prevented the occurrence of super spreader events. Hygiene practices were continuously reinforced through public messaging. Although the quarantine of infected patients was not strictly enforced by the authorities, people generally observed the rules and avoided non-essential socializing. This new public health policy combination was able to bend the curve of the disease even after the official lockdown was lifted.

Our analysis indicates that as super spreader events were avoided and wearing of masks was enforced during the post lockdown period, the curve of the disease was still bent and reduced to lower rates. The opening of offices, industries and markets did not automatically lead to a high rise in cases or positivity rates. Nor did the occasional bursts of travel during festivals and holidays. The positivity rate of the disease is now on a decreasing to stable trend for the near future, and people over the last few months have become accustomed to the new normal. If a low infection rate can be maintained, if social distancing is maintained, hygiene standards are enforced and mask wearing continued, it can be possible to conduct university admission exams in Bangladesh.

### Conclusion

The closure of educational institutions has the potential to create significant losses to the future of students and the economic

productivities of countries. Azevedo *et al.*,<sup>40</sup> in a study by the World Bank, have estimated that the closure of schools during the pandemic will result in a global fall in levels of schooling, increase dropouts from the economic shock, reduce the future earning potential of the workforce, increase inequality and waste trillions in government investments on education. In order to mitigate the effects of this great setback, governments should take measures to ensure the smooth continuation of education to build a well-trained workforce. In the context of Bangladesh, one obstacle that must be overcome now is the transition of eligible students from secondary to tertiary education. This must be done while keeping in mind the health and safety requirements of students and teachers.

Our analysis of the COVID-19 positivity rate trend in the context of lockdown enforcement and exit policies has shown that it is possible to keep the disease transmission levels low by observing some social distancing and hygiene measures, like wearing masks. Therefore, the educational policy makers can set criteria for the safe and timely conduction of admission exams using best practices. They can set a strict threshold for infection rates, below which the admission tests can be allowed. The universities can conduct the tests in smaller batches, using multiple sets of question papers, to prevent crowding of students in one exam hall at the same time. Aside from exams, other official procedures should be moved online to minimize interpersonal contact. Preparations can be made for spacious seating, and more venues and invigilators can be arranged to accommodate examinees. After the admission exams, classes can continue safely in the online platform until the

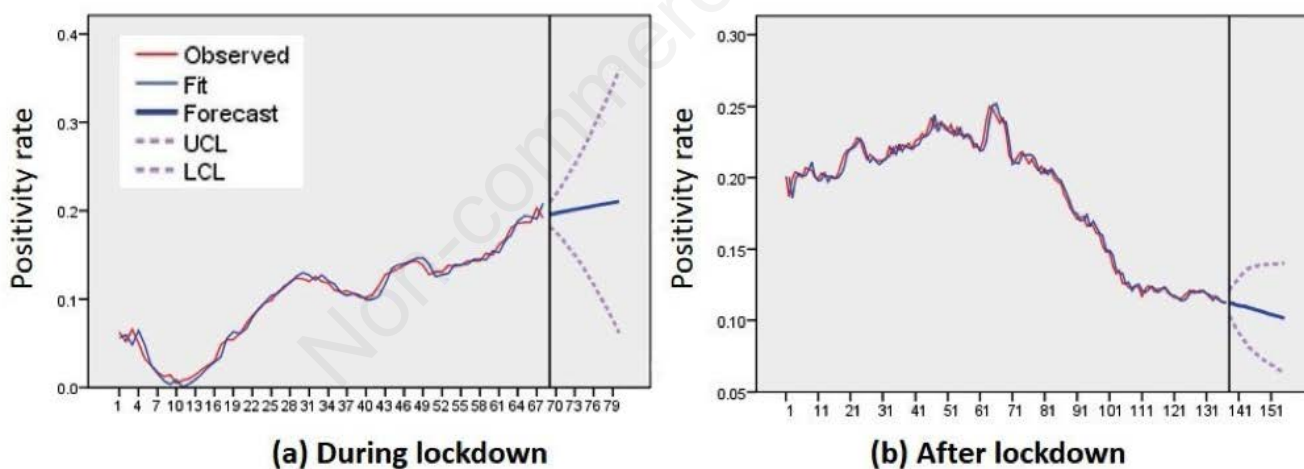


Figure 5. Forecast graphs of the two ARIMA models.

Table 1. Comparison of evaluated ARIMA models, and associated values.

Model	Parameter	Coefficient	p value	AIC	BIC	MAPE	MAE	RMSE
Lockdown period								
ARIMA(2,1,0)	AR(2)	0.381212	0.0002	-7.0721	-9.768	10.708	0.005	0.007
ARIMA(0,1,2)	MA(2)	0.320743	0.0216	-7.0439	-9.736	10.943	0.005	0.007
ARIMA(7,1,0)	AR(7)	-0.434634	0.0001	-7.0626	-9.569	9.337	0.005	0.007
ARIMA(0,1,7)	MA(7)	-0.6313	0.0001	-7.1321	-9.557	7.084	0.005	0.007
Post lockdown								
ARIMA (7,1,0)	AR(7)	-0.34316	0.0000	-7.9729	-10.527	1.736	0.003	0.004
ARIMA(0,1,7)	MA(7)	-0.32111	0.0000	-7.9652	-10.653	1.566	0.003	0.004

transmission rates of the disease decrease further or until vaccines are distributed. Furthermore, decisions should remain flexible, and if any examination is to be announced, it needs to be scheduled within the two or three weeks following the announcement date, provided the low positivity rates continue as predicted in this study. The scheduled exam dates should not be in the too distant future from the time of announcement, to avoid any adverse turn in the trajectory of the disease.

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