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Impacts of social and economic determinants of coronavirus disease (COVID-19) in Nagaland: An empirical analysis

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Abstract
The spread of novel coronavirus SARS-CoV-2, the cause of the COVID-19 pandemic has emerged as a global matter of concern in the last few of months. It has rapidly spread around the world, which initially began in the city of Wuhan, People's Republic of China and is hypothesized to originate from the group of Rhinolophus bats. The occurrences of COVID-19 infections are uneven across districts of Nagaland and the same is determined by socio-economic situations prevailing in the region. The paper is an attempt to empirically examine the socio-economic determinants of the occurrence of COVID-19 in Nagaland considering the data as of October 30, 2020. A multivariate regression analysis in a cross-sectional framework was used to analyse the impact of COVID-19 on socio and economic determinants. The findings of the study show a positive significant relationship of human development index, per capita income, returnees from other states, human mobility and below poverty line. The size of returnees and human mobility emerged to be a potential factor and positive in determining the total and new cases of COVID-19. In the wake of the COVID-19 outbreak, lockdown is the only preventive measure to avert community transmission of this disease, which is having economic, social and psychological effect on the general mass. Therefore, people-centric plan and making people more participatory and responsive in adhering to the social distancing norms in public and workplace and adopting preventive measures need to be focused on COVID-19 management strategies.

Keywords: Covid-19, human development index, crude rate of spread, returnees to destination districts, human mobility, per-capita income, below poverty line

Introduction

On December 31st 2019, a patient infected with a respiratory syndrome comparable to pneumonia was admitted in Wuhan hospital, Wuhan, Hubei providence, People Republic of China triggered with the aid of a new Ribonucleic acid beta-coronavirus, named Severe Acute Respiratory Syndrome-coronavirus 2 (SARS-CoV-2) (Huang *et al* 2020; Li *et al* 2020; Zhu *et al* 2020) [19, 41, 52]. The infection sustained by way of SARS-CoV-2 has been named coronavirus disease 19 (COVID-19). Later on COVID-19, which has now emerged as a global pandemic, was report to be first instigated from the Huanan seafood Wholesale Market, the place where live animals like frogs, bats, snakes, snails, birds, pigs, cats and dogs are regularly wholesale in Wuhan metropolis of China (Han *et al* 2020; Lu *et al* 2020; Wang *et al* 2020; Lau, *et al* 2020) [17, 32, 52, 29]. After thorough investigation of the genetic sequence of COVID-19 inflicting virus, it was once decided that contaminated individual might have visited the Huanan Seafood Market situated in the Wuhan metropolis or may have consumed infected birds or animals (Kang *et al*; 2020; Rothe *et al* 2020; Wu *et al* 2020; Sohrabi *et al* 2020) [42, 51, 45]. The virus being a infectious one has managed to spread different countries (United State of America, Germany, Turkey, Italy, Spain, Brazil) in no time (BBC news, January 31st, 2020), World Health Organization Director General Tedros Adhanom Ghebreyesus on 12th March, 2020, declared the novel Coronavirus outbreak as a global pandemic. Owing to this investigation, it was confirmed that COVID-19 causing virus was once able for community transmission through human as a carrier and thus, rapidly spread over more than 216 countries in the globe. This novel virus is transmitted from human to human due to the close contact with the contaminated person or due to the exposure to the respiratory droplets released in the course of coughing and sneezing of an infected person. This type of respiratory droplets of the contaminated person can enter into the respiratory system of a healthy human through the mouth and nose during breathing (Hui *et al* 2020; Paules et.al 2020; Krishnakumar and Rana 2020; Hunter, 2020) [20, 38]. In the past, a similar kind of pandemic have been noticed, however, due to a different group of coronaviruses named as Severe Acute Respiratory Syndrome coronavirus (SARS CoV) centred on Guangdong province, China and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in Arabian Peninsula. In 2003, SARS-CoV virus, a member of the beta-coronavirus, affected 8098 persons with a mortality rate of 9.5% spread over 26 countries in the world. In 2012, another pandemic inflicting coronavirus termed as MERS-CoV, a member of beta-coronavirus that varied from other human coronaviruses (HCoV), used to be additionally suggested to be unfolding over the Saudi Arabian countries (WHO 2020; Chan et.al 2020; Ferguson *et al* 2020; Peiris *et al* 2004). The WHO confirmed that this group of MERS-CoV affected more than 2000 persons with a mortality rate of 34.5%. After evaluation of COVID-19 syndrome, it was observed that the community transmission rate of SARS-CoV-2 is much higher in contrast to the earlier SARS-CoV outbreak (Leung, 2020; Gates, 2020) [30, 14]. Due to the excessive transmission rate of this coronavirus, the affected countries tried to manage the spread of this lethal virus by isolating the probable carriers touring from overseas countries. Furthermore, nearly all the affected nations are electing for nationwide lockdown to

prevent the community transmission COVID-19. However, it is a monotonous job to control the residents using the lockdown process for a longer period of time and therefore, the authorities need to propagate awareness among people and instruct them for correct private hygienic practices to be adopted to battle towards this pandemic and it was then classified as pandemic by the World Health Organization, imposing the adoption of tight restraint measures worldwide, such as social distancing and prohibition to attend public milieu, which had pressured people to stay at home (Fisher and Wilder-Smith 2020; Salzberger, 2020; Wilder-Smith and Freedman 2020; Roda, 2020; Hamzelou, 2020; Gilbert 2020; Kupferschmidt 2020) [13, 43, 41, 16, 27, 28]. The numbers of the registered positive COVID-19 cases are escalating exponentially and by far show no trend in being stable. Infections with SARS-CoV-2 are now widespread, and as of 31st October 2020, 45,428,731 confirmed cases have been tested in more than 216 countries, with 1,185,721 deaths (WHO, 2020). Countries like United States, Brazil, Russia, Spain, Germany, Turkey, Iran, UK, India, and Italy have the highest range of incidence of cases as well as deaths due to this global threat of novel coronavirus. The economy of the United States has suffered its most extreme slimming down since the Great recession of 2008. One of the motives for the major economic breakdown is the inevitable decisions taken by the authorities following the pointers of the WHO to keep social distancing and people staying at home to limit the number of cases of COVID-19. Some nations which followed stringent government restrictions in lieu of retaining the infectious disease were South Korea, New Zealand, Germany, and Japan. India shows the highest number of cases among the Asian nations and as it is the second-largest populous country in the world. India has surpassed Brazil to become the country with the second highest number of COVID-19 cases, as the virus continues to increase through the country of 1.3 billion population at the speedy rate of anywhere in the world (Pulla 2020; Paital 2020; Hopman, 2020) [40, 36, 18].

India recorded more than 90,000 cases overnight, bringing the number of infections in the country past 4.2 million and overtaking Brazil, which with 4.1 million cases had been the second worst-affected country for several months. India now solely lags behind the United States, which has had 8.1 million cases so far and death toll stands at 1,21,641 (as on 31st October, 2020). The eight states in North-eastern India including Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim with a blended population of about 46 million, which is about 4% of the country population. With only about 0.26% of the mentioned COVID-19 positive cases throughout the country so far, the region is going through huge hassle in containing the spread of the virus. The healthcare supervision system in the north-east India is noticeably terrible as per the National Health Profile Report 2018. The poor health care infrastructure of the region is also mirrored in the low number of COVID-19 testing centres. In Nagaland NGOs, church and community has performed a vital role in introducing and managing norms in their communities. They play a significant role in combating the COVID-19 pandemic in the region by imposing social regulations-such as social distancing-and ensuring cooperation among various ethnic groups and other stakeholders. The influence on the financial system due to COVID-19 in Nagaland has been extraordinarily disruptive. The most particular groups of affected and at risk are the unorganised sectors of both primary and secondary sector and also daily wages earners. Many rapid-growing consumer goods enterprises in the state have dramatically reduced their commercial activities. Looking at the present situation Nagaland Government has initiated several steps to work out the crises, starting with food security, and enlarge funding on health care, to sectors related to assist and extended tax schedules. The government of Nagaland is also formulating what they call 'strategies and a avenue map to move towards sustainable and self-reliant economy.' As the pandemic is crumbling world economy, Nagaland's economy is projected for an annual cash shortfall of $1216.76 million for 2020-21 based totally on April receipts from the central government. Nagaland witnessed unparalleled humanitarian disaster at some stage in the pandemic with thousands of livelihoods, especially of those who had migrated to the town especially Kohima Dimapur and Mokokchung for work. The disparity and exclusion of some communities were brought out amidst the pandemic, highlighting the need for social security.

Origin of Coronovirus diseases: A brief review

Since the first reports of novel pneumonia (COVID-19) in Wuhan, Hubei province, China, there has been great debate on the origin of the causative virus, SARS-CoV-23 (also referred to as HCoV-19). Bynoe and Tyrell in 1966 have been the first ones to study coronaviruses through extracting them from patients suffering from the common cold and referred to as it coronavirus due to the surface's similarity with a solar corona, which has four further subfamilies, i.e., gamma, beta, delta, and alpha coronaviruses. Betacoronavirus and Alphacoronaviruses originate from bats, while delta and gamma coronaviruses mainly have an effect on birds and pigs (Ather *et al*. 2020) [4]. COVID-19 belongs to coronaviruses family, which not only affects human being but can additionally spread to animals as well (Kooraki *et al*. 2020) [25]. Betacoronaviruses are associated with extreme diseases, while Alphacoronaviruses are attributed to asymptomatic infections. COVID-19 belongs to beta category, and its origin can be linked to the SARS outbreak as its genome structure is 96% similar to bat coronaviruses (Cao *et al*. 2020) [8]. The progress of preventive strategies like vaccines to fight COVID-19, the source of origin, biological mutation and the transmission rate of this virus need to be evaluated judiciously. After genetic sequencing of samples accumulated from palm civets, frequently offer in the seafood market, it was once observed that palm civet might be a secondary host of SARS-CoV (Kan *et al* 2005; Wu and McGoogan, 2020) [24]. Thereafter, researchers additionally suggested that the group of Rhinolophus bats is capable to produce anti-SARS-CoV antibodies, consequently tested that this group of bats was once the most important reservoir of the viral reproduction (Shi *et al* 2008; Paden *et al* 2008) [44]. Furthermore, genomic similarities have been discovered between SARS-CoV-2 and SARS-like bat viruses, as a result exemplifying bats as the probably the primary host of novel SARS-CoV-2. Recently, researchers revealed that anteater animals named pangolins are the possibly intermediate host for the transmission of novel SARS-CoV-2 between bats to the humans. However, to exterminate this pandemic, more investigate efforts are imperative to discover out the intermediate zoonotic source of COVID-19 and mainly its

epidemiological elements that instigated the viral transmission to the human host, for the effective control, therapy and prevention from the spreading of this lethal virus.

Emerging scenario of Nagaland COVID-19 outbreak

COVID 19 pandemic has swept the world including Nagaland in the last 6 (six) months infecting thousands of people and causing number of deaths. Nagaland, like the rest of the world, has also been exaggerated badly in all spheres of human activities. As of 30th October, 8894 positive cases, out of which 7019 have been recovered and 35 persons had been death. To date, the Nagaland is experiencing one of the worst instances of the COVID-19 outbreaks as the fourth highest confirmed cases and deaths in the Northeast India, next to Assam, Tripura and Manipur (COVID-19 Dashboard, 2020), amplified with its poor healthcare supervision system. The COVID-19 outbreak in Wuhan has reached the state of Nagaland on 22nd May 2020, with its first case confirmed on 25th May 2020 (The Hindu, 2020). Nagaland is the last of the northeastern states after Sikkim to report COVID-19 positive cases. In the beginning, coronavirus cases in Nagaland happened due coming of returnees from different states. The first three positive cases occurred on 25th May in Dimapur and Kohima as they returned from Chennai (Southern part of India). To control this spread, the Health Ministry issued travel advisory restrictions which have been similar to the previous pandemics such as Ebola, SARS, MERS, including the imposition of self-quarantine rules for 14 days to all travelers coming into the state. On 24th March first phase of 21 days lockdown commenced in Nagaland. Due to this lock down, mobility in grocery and pharmacy, recreation and retail, transit to station visits to parks, and workplaces reduced respectively. As regards, a number of other non-medical interventions like relief to stranded people, distribution of rations to migrants, preparation of quarantine centres and the entire quarantine arrangements, transport arrangements for bringing people back from different states, IEC (information, education and communication) and activities etc. The total expenditure taking both the medical and non-medical interventions comes to about $ 10 million. Though Nagaland government preventive and preparatory measures from January onwards, authorities had been into a full disaster management mode from March 18th, 2020 when the provisions of Disaster Management Act 2005 were invoked in the state. Since then, frontline workers, scientific team, administration and police, Disaster Management, Municipal authorities, other essential services departments are working to deal with more than one challenges brought by the global pandemic. The months of the lockdown resulted in the fall of employment and income, which slowly stabilized after the economy system reopened in late May in most parts of Nagaland. After zonal segmentation of districts, study showed that the worst affected areas included orange and red zones (districts with higher numbers of COVID-19 infections), and largely the urban economy. Kohima, Dimapur, Mokokchung and Wokha were estimated to have the steepest decline in GSDP. The lockdown restrictions had been imposed barring any preparation or coordination with states. Except for some essential services and activities, the rest of Nagaland economy remained shuttered during the lockdown period. Economic movement came to a grinding halt in the state. The lockdown had demoralizing impacts on an already slowing economy and people's livelihoods as shops, retailers, factories, transport, services and business establishments were shuttered. The lockdown in Nagaland did not assist in containing the spread of the coronavirus. Infection cases kept on increasing despite Nagaland being in lockdown measures (Kupferschmid, 2020) [27, 28].

Literature review

Nicola *et al*. (2020) [34] have summarized the socioeconomic outcomes of the COVID-19 pandemic. The demand for goods and service in all the sectors has decline drastically. Fear of buying due to measures like social distancing, isolating oneself, and complete ban on travels has led to shortages in stores. Healthcare and pharmaceutical industries have been experiencing a high healthcare cost and a huge shortage of medical institutions beds and PPE. Hospitality, tourism, and aviation industries are facing serious losses all over the world. The global oil price has dropped and reduction in chemical industry production has been predicted around 1.2%. It has affected learners as instructional institutions stay closed.

Stojkoski *et al*. (2020) [46] have analyzed the impact of socioeconomic factors like health infrastructure, demographic and economic determinants. The outcome exhibits that per capita income, population, and health spending have positive impact on COVID cases per million. Parameters like life expectancy, lack of hygiene, population density have a negative impact on the registered COVID-19 cases. Patel *et al*. (2020) [37] the study spotlight the stumpy socioeconomic position causes by COVID-19 pandemic. Higher level of population, unemployment and fall in income conditions of workers working in unorganized sector suffer the most in almost all over the countries. According to him, poverty makes an individual more exposed and hence vulnerable to COVID-19. He then noted that the policymakers to introduce long-term legislation to improve social welfare measures.

Aum *et al*. (2020) [3, 5] study found that an increase in infections leads to a drop in employment possibilities in the absence of lockdowns in South Korea, where there were no authorities mandated lockdown. This range expanded for countries such as the US and the UK where obligatory lockdown measures were forced.

Adams-Prassl *et al*. (2020) [2] analyze the inequality in income losses based on the kind of employment and individual uniqueness for the US and the UK. The study finds that workers who can execute none of their tasks from home are more likely to lose their job. The study also finds that younger people who have less qualification and IT abilities were significantly more likely to experience fall in their income.

Alstadsaeter *et al*. (2020) Finding shows that COVID-19 pandemic shock in Norway has a sturdy socio-economic inclined, as it has disproportionately affected the financially inclined population, including old age, parents with younger children.

Beland *et al*. (2020) [6] discuss mixed effects across occupations distribution and employees in the US economy. They show that occupations that have a higher share of employment working remotely were less affected by COVID-19. On the other hand, occupations with comparatively more workers working in proximity to others were more affected. They also find that occupations

catagorised as 'more exposed to disease' are less affected. This finding is possibly due to the number of essential workers in these occupations.

Bonadio *et al*. (2020) [7] use quantitative methods to show a global lockdown as slimming down in labour supply for 64 countries. The authors find that the average decline in actual GDP constitutes a major contraction in economic activity, with a share attributed to disruptions in global supply chains.

Elenev *et al*. (2020) [12] the impact of COVID-19 as a fall in worker productivity and a decline in labor supply which subsequently affects firm revenue. The fall in income and the subsequent non-repayment of debt service obligations create a wave of corporate defaults, which might bring down financial intermediaries.

Cespedes *et al*. (2020) formulate a minimalist economic mannequin in which COVID-19 additionally leads to loss of productivity in all the sectors of an economy. The authors forecast a vicious cycle triggered by the loss of productivity causing lower collateral values, in turn limiting the quantity of borrowing activity, leading to fall in employment, and then lower productivity. The COVID-19 shock results in unemployment and asset price deflation in all the countries.

Jinjarak *et al*. (2020) [22] Stringent social distancing measures are implemented in countries with a higher proportion of senior citizen population, higher population density, a greater proportion of employees in unorganized sector, greater degrees of democratic freedom, more international travelling, and further distance from the equator. Gupta *et al*. (2020) Mobility data are more dynamic, available at a daily rate, and they can be used to measure the impact of social distancing on different aspects, such as adherence to shelter-in place policies or labor employment. Human mobility measures have been used significantly in the last few months to apprehend mobility patterns during the COVID-19 pandemic.

Acemoglu *et al*. (2020) [1] introduce heterogeneity of danger across sub-populations. The unique sub-populations (young, middle-aged, and old-aged) have different infection, morbidity and fatality rates, as well as distinctive stages of interaction with others. These conditions give rise to targeted quarantine measures. This is because a differential lockdown policy between different risk groups can decrease the number of lives lost and negative economic outcomes to a larger extent compared to unvarying lockdown measures for all age groups.

Materials and Methods

Study Areas

Nagaland is a state in North-eastern India. It is bordered by Myanmar on the East, Arunachal Pradesh on the North, Assam on the West, and Manipur on the South. It lies between the parallels of 98^0 and 96^0 East longitude, and 26.6^0 and 27.4^0 latitude North of the Equator. It has an area of 16,579 square kilometres with a population of 19,78,502 as per the 2011 Census of India, making it one of the smallest states of India (Census, 2011).

Methodologically, data for the study have been taken from various secondary sources like the Statistical Handbook, Department of Health and Family Welfare, Government of Nagaland, World Health Organization Report. The study includes 12 (twelve) districts namely Kohima, Phek, Wokha, Zunheboto, Mokokchung, Tuensang, Mon, Dimapur, Peren, Kiphire, Longleng and Noklak as recognized by the Government of Nagaland. Different variables have been selected with proper reasons and considering their potential influence on the occurrence of infectious diseases.

Nagaland is an underdeveloped state of India, almost 71.14% of its population still living in rural sector. The socio-economic position among the people in rural areas is very pathetic compare to urban area. Agriculture is the most important economic activity, covering over 70% of the state's economy. Nagaland's GSDP grew at 9.9% compounded annually for a decade, for that reason more than doubling the per capita income (Nagaland Economy Report, 2011-12). Particularly, rural people are suffering much due to the huge gap between the rich and the poor. Many central sponsored schemes have been launched in order to eradicate poverty and generate employment by the central government in Nagaland to change the socio-economic life of the people.

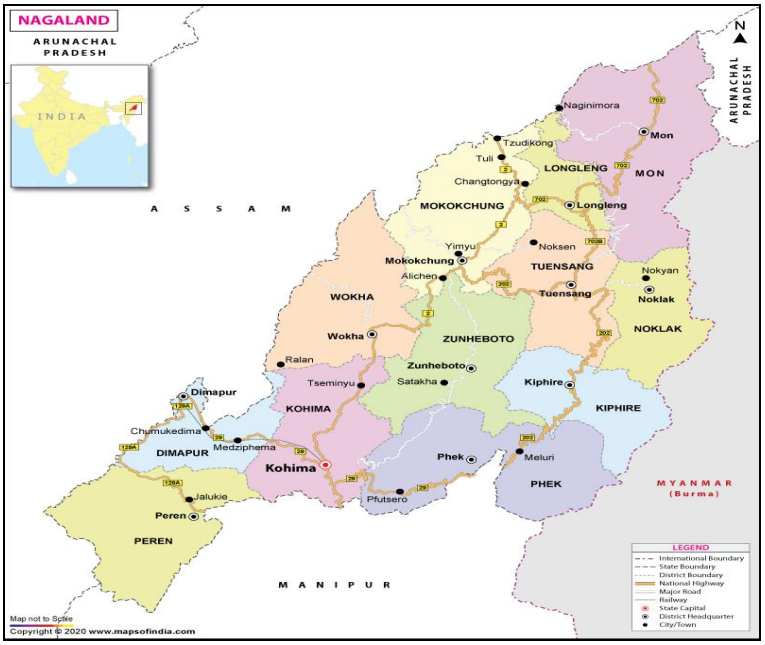

Fig 1: Nagaland map

Data analysis

Multivariate regression models to understand the determinants of the number of COVID-19 cases by districts. For the multivariate regression analysis the study uses only eleven districts as data pertaining to Noklak district have now not been covered due to the non-availability of data (newly formed district). The general functional forms of the model to point out dependent and explanatory variables are given as multivariate regression model estimation approach is adopted to obtain the coefficients.

Multivariate regression analysis

In the multivariate linear regression model, Y has normal distribution with mean

$Y=\beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+\ldots\ldots\ldots\ldots\ldots + \sigma (Y)$, sd $(Y) = \sigma$ (independent of X's)

The model parameters $\beta_0 + \beta_1 + \beta_\rho$ and σ must be estimated from data.

β_0 = intercept
β_1 β_ρ = regression coefficients
$\sigma = \sigma_{res}$ = residual standard deviation

In the equation $Y = \beta_0 + \beta_{11} + +\beta\rho X\rho$
β_1 equals the mean increase in Y per unit increase in Xi, while other Xi's are kept fixed. The estimation method follows the least squares criterion.
If b_0, b_1, $b\rho$ are the estimates of β_0, β_1, $\beta\rho$ then the "fitted" value of Y is

$Y\ fit = \beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta\rho X\rho$

The β_0, β_1……..…… b are computed such that $\sum(Y\text{-}Y_{fit})^2$ to be minimal. Since $Y–Y_{fit}$ is called the residual; one can also say that the sum of squared residuals is minimized.

Correlation matrix

Correlation matrix of the independent variables is computed to check for the presence of multi-collinearity.

$R=\frac{!}{n}X'sXs$

Where $X_s = CXD^{-1}$ with

$C = 1_n - n^{-1}1_n1_n$ denoting a centering matrix
D = diagonal (S_1……... S_p) denoting a diagonal scaling matrix

The exploration of the spread of coronavirus disease, some assumptions was formulated. Firstly, it used to be assumed a normal distribution of the cases identified in all the districts of Nagaland. The crude rate of spread for COVID-19 is calculated by dividing the number of cases recorded by the total population and every resident in the districts is assumed to have had an equal hazard of being infected by this coronovirus. This leads to the second assumption: the same crude rate of COVID-19 spread (CRS) is authentic for the people who have travelled from others states. The CRS for the province is estimated to be 4.49 per thousand through the formula i.e. the number of COVID-19 positive cases (c) divided by the total population (p).
$CRS = c/p \times 1000$.

Table 1: Descriptions of variables

Variables	Abbreviation	Description	Unit
Total Covid-19 positive case	TCOP	Per thousand population	Ratio
Human development index	HDI	Education, Longevity and Per capita income	Ratio
Population density	POD	Population density per km^2	Ratio
Total Covid-19 recovery cases	TCR	Per thousand population	Ratio
Crude rate of spread	CRS	Per thousand population	Rate
Covid-19 death	COD	Per thousand population	Ratio
Returnees to destination districts	RDD	Per thousand population	Ratio
Human Mobility	HM	Per thousand population	Ratio
Per-capita income	PCI	national income by total population	Ratio
Below poverty line	BPL	Number of people living below poverty	Percentage

Source: Data from Statistical Handbook of Nagaland (2017); Census of India (2011); Department of Health and Family Welfare, Government of Nagaland (2020). Compiled by author

Table 2: Correlation matrix for the exploratory multiple regression analyses (from 23 March to 30 June 2020)

Variables	TCOP	HDI	POD	TCR	CRS	RDD	HM	PCI	BPL
TCOP	1	0.314	0.747**	0.861**	0.758**	0.864**	0.595	0.517	-0.436
HDI		1	0.31	0.32	0.065	0.237	0.782**	0.917**	-0.929**
POD			1	0.953**	0.231	0.961**	0.298	0.449	-0.287
TCR				1	0.405	0.979**	0.405	0.504	-0.365
CRS					1	0.446	0.36	0.148	-0.315
RDD						1	0.331	0.411	-0.276
HM							1	0.890**	-0.828**
PCI								1	-0.855**
BPL									1

Source: Computed by author using SPSS software. Collected data from 23 March to 30 June 2020
*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Table 3: Correlation matrix for the exploratory multiple regression analyses (from July 1 to 30 October 2020)

Variables	TCOP	HDI	POD	TCR	CRS	COD	RDD	HM	PCI	BPL
TCOP	1	0.445	0.888**	0.994**	0.976**	0.959**	0.916**	0.953**	0.326	-0.33
HDI		1	0.31	0.476	0.469	0.354	0.237	0.448	0.889**	-0.937**
POD			1	0.836**	0.781**	0.972**	0.961**	0.966**	0.214	-0.22
TCR				1	0.990**	0.922**	0.870**	0.917**	0.358	-0.36
CRS					1	0.881**	0.840**	0.879**	0.327	-0.34
COD						1	0.978**	0.991**	0.24	-0.27
RDD							1	0.965**	0.131	-0.15
HM								1	0.303	-0.36
PCI									1	-0.843**
BPL										1

Source: Computed by author using SPSS software. Collected data from July 1 to 30 October 2020
*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

Findings and Discussion

The results examined the patterns of COVID-19 spread in Nagaland from May till October identified numbers of districts reflecting their profiles and the extent of cases and deaths along with some key macro indicators as moderating factors. The following equations have been used in the two multivariate regression models run to examine the relative importance of different determinants in explaining the total number of COVID-19 cases (TCC), i.e., dependent variable.

$Y=\beta_0$ (constant)$+ \beta_1$(HDI)$+ \beta_2$(POD)$+ \beta_3$(TCR)$+ \beta_4$(CRS)$+ \beta_5$(RDD)$+ \beta_6$(HM)$+ \beta_7$(PCI)$+ \beta_8$(BPL) $+Ɛ$ …… (Model 1)

Y=2.241+ 0.27+1.104+126.73+0.014+0.312+1.03+4.55

$Y=\beta_0$ (constant)$+ \beta_1$(HDI)$+ \beta_2$(POD)$+ \beta_3$(TCR)$+ \beta_4$(CRS)$+ \beta_5$(COD)$+ \beta_6$(RDD)$+ \beta_7$(HM)$+ \beta_8$ (PCI)$+ \beta_9$(BPL) $+Ɛ$ ……. … (Model 2)

Y=5.31+0.528+0.695+68.97+3.122+0.108+0.075+0.115+3.037

Moderator variables in the regression models included total COVID-19 positive case (TCOP), human development index (HDI), population density (POD), total Covid-19 recovery cases (TCR), crude rate of spread (CRS), COVID-19 death (COD), returnees to destination districts (RDD), human mobility (HM), per-capita income (PCI), below poverty line (BPL). The correlation matrix confirms that all the independent variables are significantly correlated with the TCOP. However, there are some collinearity problems between the HDI and PCI. The correlation coefficient (r) between the HDI and PCI is 0.91.

Table 4

	Model A		Model B	
	β coefficient	**t-value**	**β coefficient**	**t-value**
(Constant)	-479.937	-4.613	1723.59	1.118
HDI	2.241	2.413	5.31	2.60
POD	0.275	3.556	-0.528	-0.686
TCR	1.104	5.229	0.695	2.914
CRS	126.731	14.527	68.972	1.187
COD	-	-	3.122	0.064
RDD	-0.014	-3.097	-0.108	-1.232
HM	0.312	7.99	0.075	1.438
PCI	1.03	0.06	0.115	1.376
BPL	4.554	6.109	3.037	0.565
Adjusted R^2	97%		98 %	

Source: Data from Data from Statistical Handbook of Nagaland (2017); Census of India (2011); Department of Health and Family Welfare, Government of Nagaland (2020); Author calculations. Significance: ***p < 0.001; **p < 0.01; *p < 0.05.

Regression analysis results established that the total number of cases for each districts is considerably moderated by the factors included in the model. In model A, the HDI, POD, TCR, CRS, RDD, PCI and BPL explain 97% of the variance in the number of COVID-19 positive case in Nagaland, with HDI, CRS and BPL being the most important factors. Therefore, in the model B also provide an explanation for 98% of the variance, with HDI, CRS, COD and BPL being the most significant factors for TCOP. Moreover, human mobility (HM) is a statistically important factor for the TCCs in all the districts.

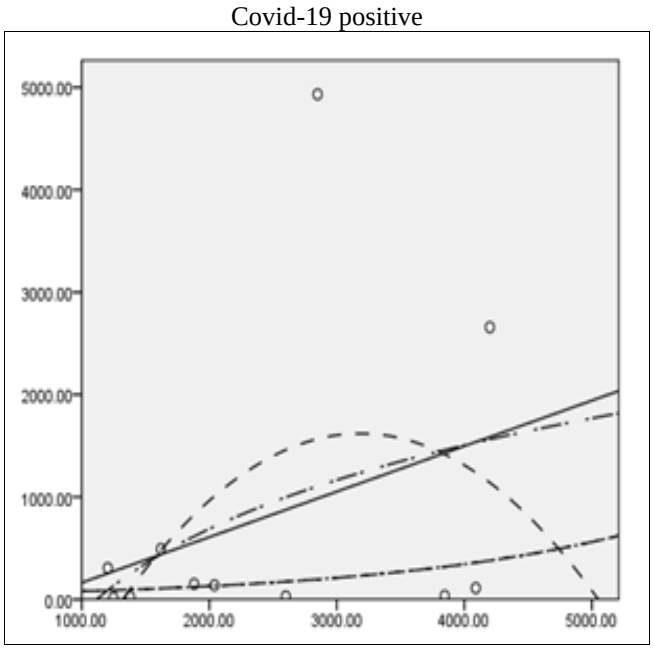

Fig 2: Per-capita income

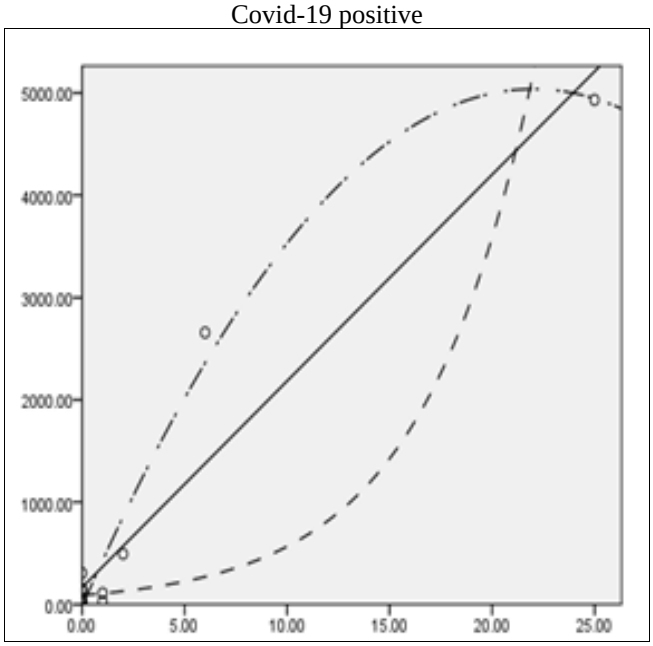

Fig 3: Covid-19 death

Correlation matrix shows a positive significant relationship of per capita income, human mobility and returnees to destinations districts on the total COVID-19 cases (refer table 1 and 2). Districts having higher per capita income, human mobility, returnees are showing higher traces of COVID-19 cases and this has been observed in Kohima, Dimapur, Peren, Mon and Mokokchung. Similar findings had been determined in the case of European, American and Asian countries. The outcomes show that each and every one unit increase in per capita income leads to 1.03 more COVID-19 cases. Per capita income coefficient emerged to be significant and positive. This suggests that districts with high per capita income are having higher COVID-19 cases in Nagaland. It has been found that economic development has led to more economic activities and more movement of people from region to region. As a result, the incidence of COVID-19 rates and exposure increases.

Considering the spread of COVID-19 among districts, the models argue that districts with higher population density and higher HDI scores have the highest COVID-19 case levels. These results tell us that every one unit increase in population density may increase 0.27 more COVID-19 cases being reported according to these models. Model A shows a positive significant relationship of HDI on the total COVID-19 cases. The findings show that every one unit increase HDI score may increase 2.4 more COVID-19 cases.

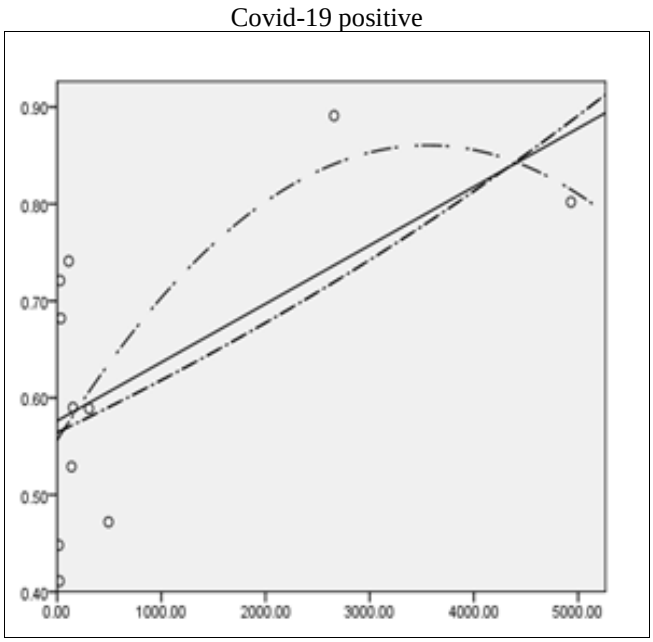

Fig 4: Human development index

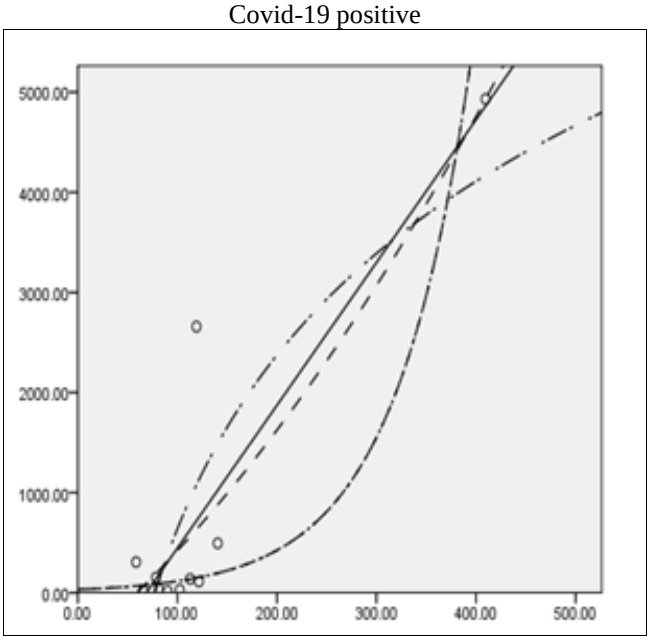

Fig 5: Population density

Another variable that was proved to be positively significant was the poverty rate. In model A positive results was found between total COVID-19 case and poverty rate. This domino effect tell us that every one unit decline in the poverty rate decreases 4.55 more COVID-19 cases being reported according to these models. The study found that Mon, Tuensang, Peren, Phek and Wokha has higher poverty

rate compare to others district, where more people live below the income line causing poverty rate to rise. The income is an important factor determining the nutritional intake of the citizens. The nutritional intake plays a very essential role in figuring out the immunity resistance of people. Studies have proved the importance of immunity in fighting the COVID-19 pandemic. The districts having high poverty rates have been inclined to more COVID-19 cases. As many people are going jobless, it is accepted for the government to provide job for those people. The Government has taken many positive steps in formulating new economic policy which would help the poor people to earn livelihood in different sectors of the economy. As a result the Government announced a number of measures to tackle the situation, from food security and extra funds for healthcare in all the districts. Different phases of Nagaland lockdown up to the "first unlock" on 1st June had varying degrees of the opening of the economy, resulting in significant upward push in employment and income, level and thus, lowering the poverty level. In model B also positive results was observed between total COVID-19 case and poverty rate. This result tell us that every one unit decline in the poverty rate decreases 3.03 more COVID-19 cases being reported according to these models.

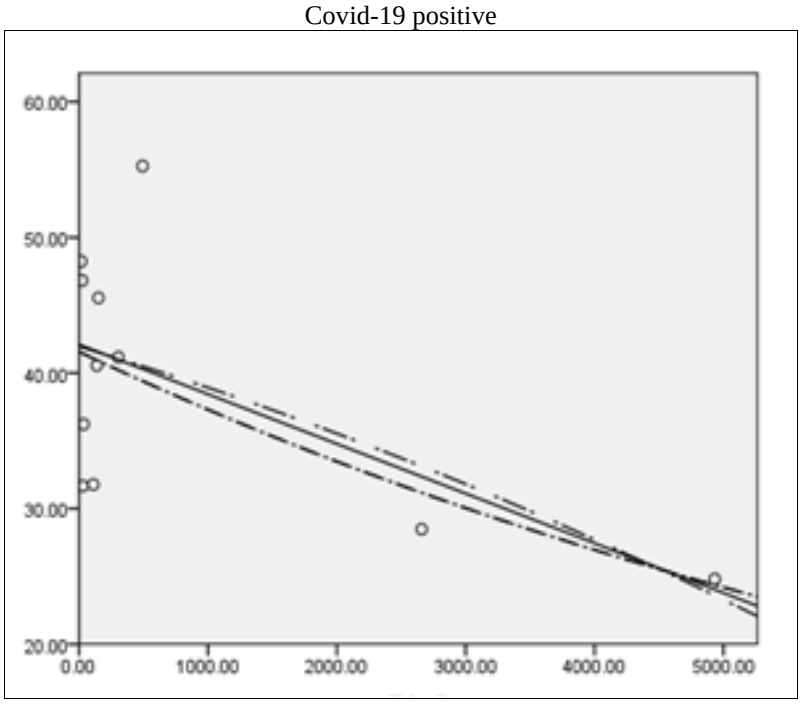

Fig 6: Below poverty line

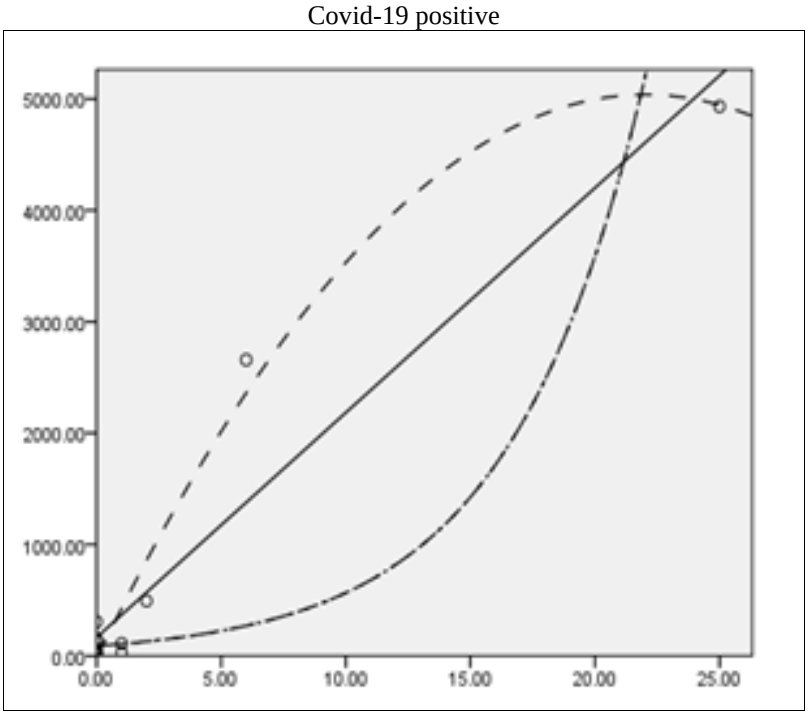

Fig 7: Covid-19 death

The crude rate of spread of COVID-19 diseases for the Nagaland was estimated to be 0.22 per thousand through the formula (23rd March-30th June) and similar increases to 4.49 from 1st of July to 30th October. This gives us a probable number of people infected who travelled to other states and also within the state. Model A results was observed between total COVID-19 case and crude rate of spread. The finding tell us that every one unit increase in the crude rate of spread increases 126.73 more COVID-19 and 68.97 for model B.

The role of returnees to destination districts in two models, in model A, the finding exhibits that every returnees from different states in a given destination state indicates a 2.1 increase in the number of COVID-19 cases. In model B, every additional returnee in Nagaland from a destination states means 3.6 more COVID-19 cases being found in Nagaland. Thus, it is not the range of returnees, however rather, the totality of human mobility in both directions. This can be an important proxy to see how state can predict the scale of and prepare for a pandemic.

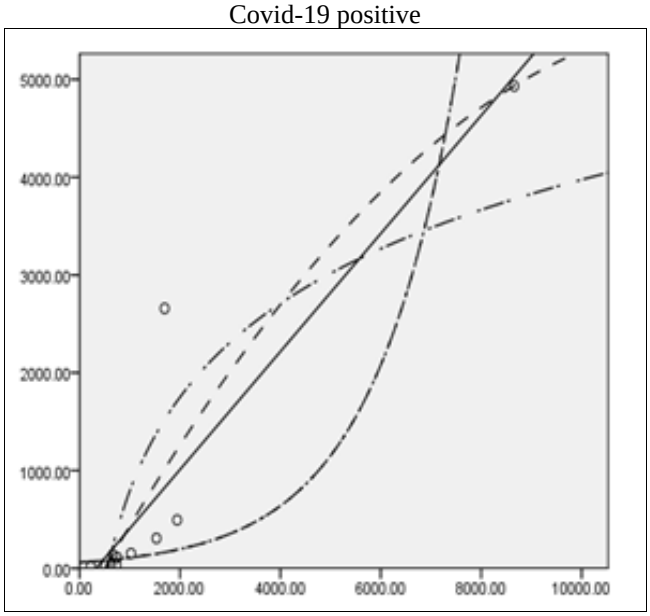

Fig 8: Returnees from other states

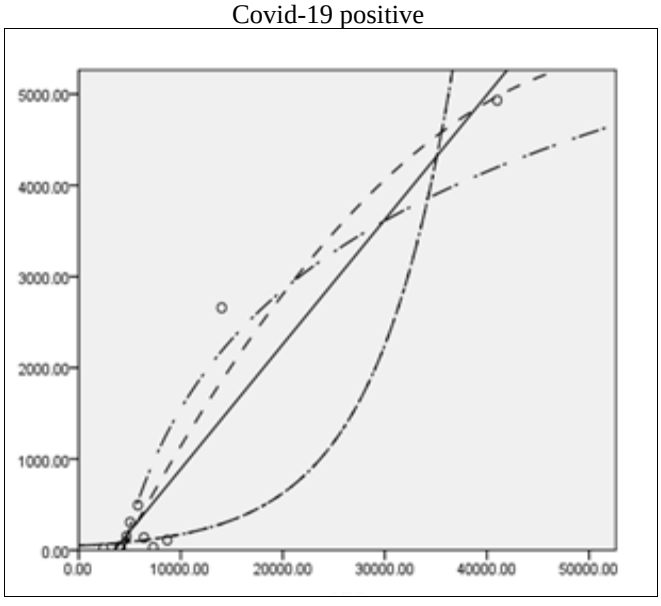

Fig 9: Human mobility

Conclusion

This paper examines the transmission dynamics of the coronavirus disease 2019 in Nagaland, considering within the districts. The data collected was comprises of two phases i.e., 23rd March to 30th June, covers key episodes such as the initial spread of the virus through Nagaland, the peak of infections in terms of household case counts, and the normal containment of the coronavirus in the region. By end July 2020, COVID-19 infections have been reported in almost all the districts. A multivariate regression model in a cross-sectional framework has been used to study the determinants that contribute to the incidence of the pandemic. A range of determinants like human development index, population density, per capita income, returnees from other states, human mobility and below poverty line are observed to have a positive significant relationship on the prevalence of total COVID-19 cases Nagaland. The domino effect exhibits that districts having higher human development index are more affected by COVID-19. Rather strategies such as stringent social distancing and contact tracing and testing are signification. The study found that districts having larger returnees from others states have been more affected by COVID-19. Therefore, people-centric plans and involvement of people are necessary to check the spread of virus. Fighting poverty has been the target of government policy. It is a known reality that a range of districts in Nagaland have low per capita incomes and poor infrastructure facilities in health. The districts in Nagaland which are more poverty ridden are additionally affected with higher COVID rates. Though it is contrasting to findings of high-income districts are also more affected because of more economic activities and movement of people. The result has found that districts with higher multi-dimensional poverty (MPI) show lower Covid-19 fatality rate as compared to districts having higher MPI.

Author Statement

I abide by academic ethics, advocating rigorous style of study. This paper does not contain any published or written content by others.

Author Contributions

All tasks have been performed by single author.

Declaration of conflicting interests

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