Original Paper

doi 10.15826/recon.2023.9.3.020
UDC 338
JEL D78, H12, I15

Socioeconomic Drivers and Risk Factors of Covid-19 Pandemic in Nigeria

I.H. Sanusi[a] ✉, **J.S. Babangida**[a,b]

[a] *Ahmadu Bello University, Lecturer and PhD Fellow, Zaria, Nigeria;* ✉ isfahis@gmail.com
[b] *Yildiz Technical University, PhD Fellow, Istanbul, Turkiye*

ABSTRACT

Relevance. The Covid-19 pandemic has prompted the need for a comprehensive understanding of its drivers and risk factors, particularly in the socioeconomic dimension. While previous research has primarily focused on biological vectors and mortality rates, less is known about the influence of socioeconomic factors on the spread of the virus. Understanding these factors is crucial for effective policy responses and addressing state-specific peculiarities.

Research Objectives. This paper aims to assess the socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria. Specifically, it examines the impact of socioeconomic forces on infection and mortality rates. The study seeks to shed light on the role of geographic distance to epicenters, the business environment, and income inequality in shaping the spread and impact of the virus.

Data and Methods. The analysis employs two pooled multivariate regression models using data from 37 sub-national entities (States) in Nigeria. The first model explores the effect of socioeconomic forces on Covid-19 infection rates, while the second model examines their influence on fatality rates. The models are based on comprehensive observations and utilize state-specific data to account for variations across regions.

Results. We found that proximity to epicenters is associated with higher infection rates, while areas with weaker business environments and higher inequality are more vulnerable. Income inequality emerges as the sole significant driver of mortality, possibly due to limited access to testing, vaccination, and treatment centers among income-constrained populations.

Conclusions. The study emphasizes the importance of considering socioeconomic factors in pandemic response strategies, particularly in the context of Covid-19 in Nigeria. We reveal that geographic proximity to epicenters, business environment strength, and income inequality significantly influence infection rates. Addressing these factors, along with recognizing the impact of income inequality on mortality, can inform targeted policies and interventions for effective pandemic management. Policymakers should consider sub-national characteristics and state-specific peculiarities to tailor responses and mitigate the spread and impact of Covid-19.

KEYWORDS
Covid-19 Pandemic, infection, mortality, Nigeria, pooled regression, risk, socioeconomic.

FOR CITATION
Sanusi I.H., Babangida J.S. (2023). Socioeconomic Drivers and Risk Factors of Covid-19 Pandemic in Nigeria. *R-Economy*, 9(3), 325–337. doi: 10.15826/recon.2023.9.3.020

Социально-экономические движущие силы и факторы риска пандемии Covid-19 в Нигерии

И.Х. Сануси[а] ✉, **Дж.С. Бабангида**[а,б]

[а] *Университет Ахмаду Белло, Зария, Нигерия;* ✉ isfahis@gmail.com
[б] *Технический университет Йылдыз, Стамбул, Турция*

АННОТАЦИЯ

Актуальность. Пандемия Covid-19 вызвала необходимость всестороннего понимания ее движущих сил и факторов риска, особенно в социально-экономическом измерении. Хотя предыдущие исследования в основном были сосредоточены на биологических переносчиках и уровне смертности, о влиянии социально-экономических факторов на распространение вируса известно меньше. Понимание этих факторов имеет решающее значение для эффективных политических мер и решения специфических особенностей государства.

КЛЮЧЕВЫЕ СЛОВА
пандемия Covid-19; инфекционное заболевание; смертность; Нигерия; сквозная регрессия; риск; социально-экономический

Online ISSN 2412-0731

Цель исследования. Целью данной статьи является оценка социально-экономических движущих сил и факторов риска пандемии Covid-19 в Нигерии. В частности, в нем исследуется влияние социально-экономических факторов на уровень заражения и смертности. Исследование призвано пролить свет на роль географического расстояния до эпицентров, деловой среды и неравенства доходов в формировании распространения и воздействия вируса.
Данные и методы. В анализе используются две модели сквозной регрессии с использованием данных из 37 субнациональных образований (штатов) в Нигерии. Первая модель исследует влияние социально-экономических факторов на уровень заражения Covid-19, а вторая модель исследует их влияние на уровень смертности. Модели основаны на комплексных наблюдениях и используют данные по конкретным штатам для учета различий между регионами.
Результаты. Мы обнаружили, что близость к эпицентрам связана с более высоким уровнем заражения, в то время как районы с более слабой деловой средой и более высоким уровнем неравенства более уязвимы. Неравенство доходов становится единственной значимой причиной смертности, возможно, из-за ограниченного доступа к центрам тестирования, вакцинации и лечения среди групп населения с ограниченными доходами.
Заключение. В исследовании подчеркивается важность учета социально-экономических факторов в стратегиях реагирования на пандемию, особенно в контексте Covid-19 в Нигерии. Мы обнаружили, что географическая близость к эпицентрам, сила деловой среды и неравенство доходов существенно влияют на уровень заражения. Устранение этих факторов, наряду с признанием влияния неравенства доходов на смертность, может стать основой для целенаправленной политики и мер по эффективному управлению пандемией. Политики должны учитывать субнациональные особенности и особенности штата, чтобы адаптировать меры реагирования и смягчить распространение и воздействие Covid-19.

ДЛЯ ЦИТИРОВАНИЯ
Sanusi I.H., Babangida J.S. (2023). Socioeconomic Drivers and Risk Factors of Covid-19 Pandemic in Nigeria. *R-Economy*, 9(3), 325–337. doi: 10.15826/recon.2023.9.3.020

尼日利亚新冠疫情的社会经济驱动因素和风险因素

萨努西[a)]、巴班吉达[a,b)]
[a)] 艾哈迈杜·贝洛大学，扎里亚，尼日利亚；邮箱：✉ isfahis@gmail.com
[б)] 耶尔德兹技术大学，伊斯坦布尔，土耳其

摘要
现实性：由于新冠病毒带来的危机，有必要全面了解其驱动因**素和**风险因素，特别是社会经济方面的因素。尽管之前的研究主要集中在生物媒介和死亡率上，但人们对社会经济因素对于病毒传播的影响知之甚少。了解这些因素对**制定有效的政策和解决各州的具体**问题**至关重要。
研究目标：本文旨在评估尼日利亚**新冠疫情期社会**经济驱动因素和风险因素。具体而言，它探讨了社会经济因素对感染率和死亡率的影响。该研究旨在揭示距**病毒震中的地理距离、商**业环境和收入不平等**因素在影响病毒**传播和影响方面的作用。
数据和方法：本分析使用了两个端对端回归模型，使用的数据来自尼日利亚的37 **个次国家**实体（州）。第一个模型研究社会经济因素对**新冠感染率的影响**，**第二个模型研究社会**经济因素对死亡率的影响。这些模型以综合观测数据为基础，并使用各州的具体数据来考虑地区之间的差异。
研究结果：我们发现，靠近**病毒震中的地区感染率**较高，而商业环境较弱和不平等程度较高的地区则更易受损害。**收入不平等是造成死亡的唯一重要原因**，这可能是由于收入有限的人群获得检测、疫苗接种和治疗中心**的机会有限。**
结论：该研究强调了在**疫情**应对策略中考虑社会经济因素的重要性，特别是在尼日利亚出现**新冠病毒的背景下。我**们发现，距离**病毒震中的地理位置、商**业环境的强度和收入不平等对感染率有重大影响。解决这些因素，同时认识到收入不平等对死亡率的影响，可以为有针对性的政**策和干**预措施提供**基**础，**从而有效**应对疫情。**政策制定者**应考虑国家以下各级和各州的具体情况，以便有针对性地采取应对措施，减轻**新冠病毒的**传播和影响。

关键词
冠状病毒疫情、感染、死亡、尼日利亚、**端到端回**归、风险、**社会**经济

供引用
Sanusi I.H., Babangida J.S. (2023). Socioeconomic Drivers and Risk Factors of Covid-19 Pandemic in Nigeria. *R-Economy*, 9(3), 325–337. doi: 10.15826/recon.2023.9.3.020

Online ISSN 2412-0731

Introduction

The outbreak of the Coronavirus disease 2019 (henceforth Covid-19) pandemic, which started out as a health shock, has pushed the global economy into fragility by disrupting supply chains, imposing bottlenecks on international trade, dipping stock markets and labour market displacement. However, the effects and drivers of the pandemic would vary from one country to another as a result of the different restriction measures put in place. Variations in the level of exposure risks arise due to context-specific limitations and recommendation aimed at slowing down the transmission of COVID-19 in many countries (Billingsley et al., 2022). Behind the grim number of infections and the consequent costs to human life, governments in different countries have implemented a variety of measures to limit the spread of the virus, with such policy measures as travel restrictions, quarantines, partial and total lockdowns, school and business closure as some of the prominent examples.

Earlier empirical studies have attempted to show different socioeconomic conditions that generally explain differences in health outcomes and the spread of diseases including demographic structure, health care system, economic wellbeing, social characteristics, and natural environment, but not specifically on the Covid-19 due to the novel nature of the virus. Since the outbreak of the Covid-19 pandemic, research efforts have been focused more on the biological and epidemiological forces behind the spread and fatality of the virus but particularly less so on the socioeconomic factors linked to the pandemic. As a result, recent studies have tried to examine the socioeconomic drivers of Covid-19 at sub-national, country, and cross-country levels. The expectation is that socioeconomic factors such as geographical location and income poverty must be accounted for if policy responses are to be effective and inclusive.

In the context of Nigeria, a total of 164,719 confirmed Covid-19 infections have been documented, with some 2,062 deaths and approximately 162,657 recoveries as of April 25, 2021 (Nigeria Centre for Disease Control (NCDC) 2021). The spatial distribution of the pandemic has been uneven with some states experiencing a greater brunt in infections relative to others. For instance, Lagos, Kano and Abuja represent three states with the highest incidence of Covid-19 while Benue, Kogi and Cross rivers have the lowest incidence. This means that Covid-19 risk factors could be unequal across the country as could policy responses. Like the rest of the world, policy responses in Nigeria aimed at mitigating the spread of the pandemic have been uniform, total and decisive, including lockdown measures and travel restrictions. As a consequence, jobs and livelihoods have been lost, with many pushed to poverty and starvation as a result (Ajibo, 2020). One of the main explanations to such uniform and sub-optimal policy responses has been the lack of empirical evidence on the socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria.

This paper is a response to the need for empirical evidence on the socioeconomic drivers and risk factors of Covid-19 pandemic Nigeria. Therefore, this paper hypothesizes that the economic costs posed by the Covid-19 pandemic could have been minimized if policy responses had been based on the underlying heterogeneity in the distribution of socioeconomic drivers and risk factors across the states in Nigeria. The methodological approach relies on state-level data on Covid-19 and other socioeconomic variables, making it possible to consider a cross-section of 37 sub-national governments in Nigeria. The paper thus explores which underlying socioeconomic conditions could be instrumental for the spread of Covid-19 in Nigeria. More specifically, given that several factors have been identified in previous empirical studies for different country contexts, this paper interrogates some of those factors to show whether they equally apply to Nigeria, or which of those are more important in the case of Nigeria. In this paper, we assess the socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria. Specifically, it examines the impact of socioeconomic forces on infection and mortality rates.

The paper is structured as follows. Section 1 comprises the introduction and section 2 discuss the literature. Section 3 discusses stylized facts about Covid-19 pandemic in Nigeria. Section 4 describes the data and methodology, in which issues related to data and key variables are discussed. The presentation and discussion of result is provided in section 5 while section 6 concludes the paper.

Theoretical Basis

There are vast number of studies that have attempted to show different socioeconomic conditions that generally explain differences in health outcomes and the spread of diseases including de-

Online ISSN 2412-0731

mographic structure (Ainsworth & Dayton, 2003; Gardner et al., 2020; Wallinga et al., 2006), health care system (Tanne et al., 2020; Zanakis et al., 2007), economic wellbeing (Adda, 2016; Nagano et al., 2020; Strauss et al., 1998), social characteristics (Chatters, 2010; Folland, 2008), and natural environment (Braga et al., 2002; Clay et al., 2018; Wu et al., 2020), but not specifically on Covid-19 due to the novel nature of the virus. Since the outbreak of the Covid-19 pandemic, research efforts have been focused more on the biological and epidemiological forces behind the spread and fatality of the virus but particularly less so on the socioeconomic forces linked to the pandemic. As a result, recent studies have tried to examine the socioeconomic drivers of Covid-19 both at country and sub-country levels (see (Sá, 2020; Qiu et al., 2020; Grekousis et al., 2022) and cross-country (see for example Jain & Singh, 2020; Stojkoski et al., 2020).

The Covid-19 pandemic has posed many questions for policy makers in their attempt to identify possible reasons for its rapid widespread. Considering this, certain studies on Covid-19 suggest that socioeconomic factors are positively related to the spread of the virus. In an attempt to uncover such a potential causal link, Sá (2020) estimated a simple linear regression model of infections and mortality on observable socioeconomic characteristics in England and Wales. The first estimates are based on basic demographic attributes while the second estimates consider deprivation, use of public transport and self-reported health. Results from the correlation and regression analysis show higher Covid-19 prevalence in local areas with larger households, poor self-reported health, and extensive use of public transportation. This suggests that places with large household sizes and extensive public transport commuting systems have more risk of Covid-19 infections.

In a similar study, Qiu et al. (2020) used the instrumental variable regression to examine the impact of socioeconomic factors on the transmission of Covid-19 virus based on a cross-sectional dataset covering 304 cities in China. Their results revealed that population outflows from the pandemic region have a significant impact on transmission rate with cities having more medical doctors recording lower transmission rates. They further show that cities with high GDP per capita have higher transmission rates, and that social interactions increase with increase in economic activities while cities with higher population density have lower transmission. On the environmental effect, they found transmission rate to be lower with weather conditions.

In a more extensive study, Stojkoski et al. (2020) leverage on the Bayesian model averaging (BMA) technique and a country-level data to investigate the potential impact of a diverse set of socioeconomic factors (multiple determinants - 31) in 106 countries during the first wave of contagions. The corona virus determinants Jointness space developed in the study show that the true (parsimonious) model can be explained by a few determinants, but the explanatory power of each determinant is itself a matter of country-specific fixed effects due to heterogeneity in socioeconomic characteristics across the countries. This study essentially emphasized the case for (policy implication on) preventive measures aimed at attenuating future pandemics. In support of this, Sannigrahi et al. (2020) utilised the spatial regression to examine the relation between socio-demographic factors and Covid-19 in Europe. Their results showed the role of population, poverty, and income in reducing the Covid-19 fatalities in Europe.

In terms of differences in Covid-19 incidence across the world, Jain & Singh (2020) examine the socioeconomic determinants of Covid-19 using regression analysis. They found the effect of Covid-19 to be higher in the developed countries with democracy having a positive effect on the spread and fatality of the virus. Interestingly, the availability of extensive testing facilities has been shown to be useful in containing the rates of spread and death from Covid-19. Overall, good governance plays important role in reducing the spread and fatality of Covid-19. Similarly, Koc & Sarac (2020) also examine the impact of socio-economic, demographic and health factors on Covid-19 for OECD countries (fatalities and mortalities) using a multiple linear regression. They found that higher share of health care expenditure from GDP, higher health conditions resulting from obesity and high blood glucose levels and index for government stringent measures exert great influence on Covid-19. The rate of tobacco usage has also been shown to be influential for Covid-19 fatalities across the OECD countries.

Based on different scenarios of environmental, demographic and health care factors, Perone (2021) investigated the determinants of Covid-19 fatality and mortality rate in 20 regions and 107 provinces in Italy using regression and agglomerative clustering method respectively. The estimates of the regression model revealed that overall health care efficiency,

Online ISSN 2412-0731

physician density and temperature have negative impact on the fatality rate. While aged population, car and firm density, air pollutant concentrations, relative humidity, health care saturation (critical care bed, ordinary care beds) have positive effect on fatality rate. From the clustering method analysis, it is shown that mortality rate is prevalent in the northern region as compared to less effect in the southern provinces. This supports the findings of Aron & Muellbauer (2022) that capacity constraints on hospital beds and staff determines death rate among adults. Similarly, Buja et al. (2020) investigated the demographic, socio-economic and health care determinants of Covid in Northern province of Italy using OLS regression. Their results show Covid-19 to correlate negatively with age index. This implies that the virus is more likely to affect older population. On the other hand, their result document that employment, public transport per capita, population and in-house density have positive correlation with Covid-19 fatalities. Under the health care factors, the province with large private health care facilities witnessed more fatalities.

In a more recent study, Ehlert (2021) used a multivariate spatial model to explore the relationship between socioeconomic, demographic and health care variables and Covid-19 in Germany. Their result suggests that average age, population density and the share of employment in elderly care have positive impact on Covid-19 (both cases and deaths). Physician density and proportion of school children is revealed to have a negative impact on Covid-19 during the first wave in Germany. While using quantile regression to assess the role of socio-spatial determinants of Covid-19, Sigler et al. (2021) indicates that globalisation, settlement and population exert influence on Covid-19 transmission. They also show that household size, aged population and globalisation predicts the surge in Covid-19 fatalities in countries with low cases. In countries with high cases, human development index and total population are shown to be the predicting factors of Covid-19 transmission. (Grekousis et al., 2022) examined socioeconomic and health determinants of Covid-19 mortality rate. They found that Covid-19 moratlity rate of depends on complex factors of demographic, socioeconomic and health characteristics such as income, family size, age, health insurance. In a latest study to identify the relationship between health, demographic and environmental factors with Covid-19, He et al. (2023) reveal the role of obesity and humidity as significant factors affecting Covid-19 in the Arkansas region of US.

Taking the existing literature on Covid-19, there is predominant focus given to biological and epidemiological aspects of the virus, neglecting some socioeconomic factors that contribute to its spread and mortality. While recent studies have examined the socioeconomic drivers of Covid-19 at both national and sub-national levels in various countries, there is a dearth of research specifically investigating the socioeconomic determinants of the virus in most developing economies, like Nigeria. The limited studies conducted in developing economies primarily explored general socioeconomic conditions and their impact on health outcomes, without specifically addressing Covid-19. Therefore, this study using disaggregated data aims to fill this gap by examining the specific socioeconomic determinants of Covid-19 infection and mortality rate in the Nigerian context, providing valuable insights for effective policy responses and interventions.

Covid-19 Pandemic in Nigeria

In late 2019, the world experienced the outbreak of the Covid-19 virus from Wuhan district of China. The spread of the virus has led to a widespread fear among people due to the ease with which it is transmitted from human to human. The Covid-19 virus moved to other economies through human-to-human contact, with the consequent health catastrophe metamorphosing into economic and financial crises for most countries. Besides the costs to human lives, other economic costs abound. For instance, the outbreak of the virus has led to drastic disruptions in supply chains, which have continued to affect the economy through a sharp reduction in domestic production and significant decreases in export revenue.

Categorically, some states in Nigeria experienced a greater brunt of the Covid-19 risk with incidence of high cases relative to others. For instance, Lagos, Kano and Abuja are the three states with the highest incidence of Covid-19 while Benue, Kogi and Cross rivers had the lowest incidence (See Figure 1). Geographically and economically, the curious case of these extreme situations is one that might be rooted in geographical and economic polarizations. The questions skirting the mind could be on the forces that explain this observed pattern in Covid-19 spread and whether they could be linked to certain socio-economic factors. What socioeconomic factors explain the variation in Covid-19 infection and mortality rates in Nigeria?

Online ISSN 2412-0731

Figure 1. *Distribution of cumulative cases*
Source: Nigeria Centre for Disease Control (2021)

Figure 1 paints a picture of Covid-19 infection across Nigerian states as of April 25, 2021. There are four categories of states: 1 – 100, 101 – l, 000, 1,001 – 10,000, and 10,000+. Two states with the highest number of infections are FCT Abuja and Lagos, each with more than ten thousand confirmed cases of infection. These epicentres also happen to be satellite and predominantly metropolitan. On the other extreme, Kogi state falls into the first category with number of confirmed cases not more than a hundred, representing a stark outlier despite its close proximity to FCT Abuja as one of the main epicentres. A large majority of states fall however into the third category with infections rates around 1,001 – 10,000.

In terms of effects, many businesses have had different experiences during the pandemic in accordance with the overall measures put in place by the Nigerian government. These measures resulted in limited mobility and constrained economic activities, with tourism and aviation industry as the worst hit. Such policy measures have also subjected thousands of people to hunger and starvation as most workers in Nigeria live on daily wage and therefore could not cope with the consequent wages and salary cuts from employers. It is reported that the labour market experiences large job destruction. This corroborates the ILO report of about 25 million jobs being lost as a result of this global pandemic, costing the world between $860 billion and $3.4 trillion (ILO, 2020). In response to the unprecedented vulnerabilities among the population, the government rolled out numerous social and economic measures to mitigate the impact of the pandemic. For instance, economic stimulus package was introduced to support businesses and individuals. The aim was to provide 50 percent of tax rebates to registered businesses. One of the main weaknesses of this policy is the fact that it targets formal businesses which accounts for only about 10 percent of the total workforce, despite the fact that 65 percent of Nigeria's GDP comes from the informal sector. What this implies is that majority of businesses and individuals are excluded. Another economic policy of cash transfer was introduced in April 2020 to provide support to poor and vulnerable households, in addition to other safety nets such as the CBN stimulus programme and the provision of palliatives to vulnerable households. Thus, it is pertinent to note that many of the policy responses are inconsistent with the reality, magnitude and spatial distribution of the pandemic.

Data and Methods

The variables used in this paper draws from a set of socioeconomic indicators identified from available empirical studies on the links between Covid-19 and socioeconomic variables. The variables include urbanization, the level of economic activity, proximity, household size, income inequality, size of population, population density, poverty, deprivation, and institutions (Jain and Singh 2020; Sá 2020; Stojkoski et al. 2020). Table 1 below contains the variables used, their measurement and respective data sources.

Online ISSN 2412-0731

Table 1

Variables and Indicators

Variable	Measurement	Source
Infection	Cumulative number of Covid-19 cases	NCDC (2021)
Mortality	Cumulative number of Covid-19 deaths	NCDC (2021)
Urbanization	Number of MSMEs	National Bureau of Statistics (2017)
Economic activity	Internally Generated Revenue (IGR)	National Bureau of Statistics (2019)
Proximity	Distance from Epicenter (km2)	distance calculator (distancefromto.net)
Demography	Population/density	National Population Commission (NPC)
Deprivation	Capability Deprivation Index (CDI)	Computed from NBS- NGHS (2016)
Poverty	Poverty Headcount, % of population	National Bureau of Statistics (2020)
Income inequality	GINI	National Bureau of Statistics (2020)
Healthcare	Immunization Coverage (measles)	National Bureau of Statistics (2019)
Resilience	Business Environment Index (BEI)	African Heritage Institution-BECANS (2017)

Source: The authors' compilation

Accordingly, data on Covid-19 infection and mortality across states is sourced from the Nigeria Center for Disease Control (NCDC, 2021) while information on the number of MSMEs, IGR, poverty headcount, deprivation, income inequality, and immunization coverage are obtained from the National Bureau of Statistics at different points in time (NBS, 2016, 2017, 2019, 2020). Similarly, information on the variation in the quality of business environment (BEI) across states is obtained from the African Heritage Institution BECANS 2017 dataset. The use of pooled data in this paper is informed by the lack of time-consistent series across sub-national entities in Nigeria.

In terms of measurement and a priori expectations, we first measure urbanization by the number of MSMEs while IGR is used to capture the level of economic activity. The distribution of MSMEs and IGR across states is itself an indicator of market size, which is expected to have a positive relationship with Covid-19 incidence. Secondly, distance from epicenter is a spatial indicator of proximity, and is therefore expected to have a negative effect on the spread of Covid-19. Areas with high population size and density are expected to have higher infection and mortality rates. Similarly, deprivation, poverty and inequality tend to exacerbate the prevalence of disease, but it is not yet obvious whether they are linked to Covid-19. Lastly, immunization coverage and business environment are expected to have a negative effect on infection and mortality rates.

To guide the estimation process in this paper, we specify a pooled multivariate regression model of the functional form (see, e.g., Sá, 2020).

$$Y = f(X_1, X_2, X_3, \dots, X_n) \dots \quad (1)$$

where Y is the outcome variable and X is a vector of observable state-level characteristics. Thus in what follows, two multivariate regression models are specified in line with the socioeconomic variables identified in the previous section. These are expressed in the following equations,

$$INF_i = \beta_0 + \beta_1 SME_i + \beta_2 DFE_i + \beta_3 PPN_i + \beta_4 PPD_i + \beta_5 IGR_i + \beta_6 BEI_i + \beta_7 IMZ_i + \beta_8 IIN_i + \beta_9 POV_i + \beta_{10} DEP_i + \varepsilon_i \dots \quad (2)$$

$$MOR_i = \beta_0 + \beta_1 SME_i + \beta_2 DFE_i + \beta_3 PPN_i + \beta_4 PPD_i + \beta_5 IGR_i + \beta_6 BEI_i + \beta_7 IMZ_i + \beta_8 IIN_i + \beta_9 POV_i + \beta_{10} DEP_i + \varepsilon_i \dots \quad (3)$$

Where INF_i and MOR_i are the outcomes representing the cumulative rates of Covid-19 infection and mortality for ith state; SME_i represent the number of small and medium scale enterprises (SMSEs) for ith state; DFE_i is the physical distance from epicentre for ith state measured in kilometre square; PPN_i and PPD_i stand for the respective population and population density for

Online ISSN 2412-0731

state i; IGR_i stands for internally generated revenue (IGR) for state i measured in NGN; BEI_i is an index of business environment for ith state; IMZ_i is immunization coverage; IIN_i, POV_i and DEP_i are rates of income inequality, poverty, and deprivation respectively for ith state; β_0 is the intercept and $\beta_1, \beta_2, \ldots, \beta_{10}$ capture the parameters of the explanatory variables to be estimated; the subscript i shows that the source of variation is individual entities.

Equation 2 expresses Covid-19 infection as a function of number of SMEs, distance from epicenter, population size and density, revenue, business environment, immunization coverage, inequality, poverty, and deprivation, all of which are assumed to be exogenous. In equation 3, Covid-19 mortality is expressed as a function of the same exogenous variables as in the first model. The model describes Covid-19 infection and mortality as a function of exogenous individual states characteristics. These characteristics represent the possible socioeconomic drivers and risk factors of the Covid-19 pandemic in Nigeria. The models are expected to show the direction, size and significance of each explanatory variable with respect to Covid-19 infection and mortality.

Results and Discussion

This section describes the properties of the variables used in regression models. The statistics describe the number of cross-sectional observations, mean values, standard deviations, minimum and maximum values as shown in Table 2 below.

Table 2

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Covid-19 Infection	37	4451.86	9802.32	5	58291
Covid-19 Mortality	37	55.7297	77.4143	2	439
MSMEs	37	1120809	581531	385489	3329156
Distance from epicentre	37	367.892	137.663	11	659
Population	37	556139	3823720	2277961	2.48e+07
P. Density	37	696.568	1619.43	56.3	7420.5
IGR	37	3.16e+10	6.37e+10	4.38e+09	3.82e+11
Business environment index	35	50.9	5.835641	34.8	59.4
Immunization	37	30.2784	17.07881	1.8	68.1
Gini index	36	28.4556	3.387272	23.49	40.2
Poverty rate	36	42.3511	26.08721	4.5	87.73
Deprivation index	37	0.481427	0.050644	0.33825	0.57289

Source: The authors' calculation

There are 37 observations on Covid-19 infection and mortality which means that data is available across all the sub-national governments (states) in Nigeria. The mean rate of infection is 4451.865 with a standard deviation of 9802.322. Although the mean shows the average rate of infection in Nigeria, the standard deviation indicates that there are differences in infection rates across the states within Nigeria. In the case of mortality, the average rate is quiet low compared to that of infection. This suggests that there have been high recovery rates since few infections could have resulted in mortality. The respective minimum and maximum mortality cases of 2 and 439 also point to uneven dispersion across the states. As far as the outcome variables are concerned, one implication is that policy responses need to be targeted in order to optimize the balance between the need to guarantee safety and that of protecting livelihoods.

Online ISSN 2412-0731

Table 3

Covid-19 Infection Regression Results

Variable	Coefficient	Std. Error	p-value
MSMEs	-0.0050**	0.00200	0.0194
Distance to epicenter	-9.3409**	4.28490	0.0397
Population	0.0011**	0.00041	0.0122
Density	0.1195	0.48030	0.8057
IGR	0.0000***	0.00000	<0.0001
BEI	-247.9324**	95.7734	0.0164
Immunization coverage	98.2193	61.0140	0.1211
Inequality	490.1255***	146.581	0.0028
Poverty	16.8594	38.6137	0.6665
Deprivation	-22805.39	14569.7	0.1312
R^2	0.9591		

*Note: * indicates 10% level of significance; ** indicates 5% level of significance; *** indicates 1% level of significance*

The estimates from Table 3 above show the respective direction, magnitude and statistical significance of the coefficients in the Covid-19 infection model. The coefficients represent the drivers and risk factors of infection. The coefficient of SMSEs is -0.005, indicating not just a negative and small effect, but one that is also statistically significant with asymptotic probability value of 0.019. The coefficient of geographical distance to epicenter is -9.34 and its corresponding asymptotic probability value of approximately 0.04 suggests strong effect at the 5 percent level. This suggests that a 1 km distance away from the epicenter reduces the chances of infection by 9 persons. Population coefficient has a value of 0.001 and a probability value of 0.01, implying a very small but statistically significant effect However, the coefficient of population density is 0.11 and the corresponding probability value is approximately 0.81. The size of IGR is small as well (almost zero) but its asymptotic probability value shows high significance with less than 0.0001. The coefficient of BEI is negative, sizable (-247.93) and statistically significant with a probability value of approximately 0.02, which then means that a percentage increase in the business environment index reduces the chances of infection by approximately 248 persons. The coefficients of immunization, poverty and deprivation are 98.21, 16.86 and -22805.39 respectively while their respective probability values are 0.12, 0.66 and 0.13 are not significant enough. The coefficient of inequality is 490.13 and significant at the 1 percent level with a probability of 0.003, which then suggests that a percentage rise in Gini coefficient is associated with approximately 490 more Covid-19 cases. With respect to these results, the analysis below is based on the coefficients that have levels of significance within acceptable limits.

The results suggest, firstly, that states located geographically far away from the epicenter are less likely to have high infection rates as compared to those within proximate location. Secondly, the measure of resilience shows, as expected, that the higher the quality of business environment for any given state, the lower the infection rate. Thirdly, states with relatively higher rates of income inequality tend to have higher infection levels. This is not surprising since income distribution is directly associated with access to sanitation and healthcare facilities. All in all, the coefficients with simultaneously large and statistically significant effects on Covid-19 infection are distance to epicenter, quality of business environment, and income inequality.

The estimates presented in Table 4 above show the respective direction, magnitude and statistical significance of the coefficients in the Covid-19 mortality model as expressed in equation 3.

Online ISSN 2412-0731

Table 4

Covid-19 Mortality Regression Results

Variable	Coefficient	Std. Error	p-value
MSMEs	-0.00006*	0.00003	0.0581
Distance to epicenter	-0.0048	0.06156	0.9392
Population	0.000015**	0.00000	0.0201
Density	0.0018	0.00690	0.0732
IGR	0.0000*	0.00000	0.7982
BEI	-0.5279	1.37600	0.7048
Immunization coverage	0.6246	0.87660	0.4833
Inequality	3.8622*	2.10590	0.0796
Poverty	-0.4225	0.55480	0.4541
Deprivation	-0.193.93	209.323	0.3638
R^2	0.8636		

*Note: * indicates 10% level of significance; ** indicates 5% level of significance; *** indicates 1% level of significance*

The coefficients represent the drivers and risk factors of infection. The value of the coefficient of MSMEs is -0.00006, which shows negative and statistically significant effect on mortality at the 10 percent level. However, the size of the impact is negligible. Distance to epicenter has a coefficient of -0.0048 with a probability value of 0.94, indicating the absence of any statistical significance. The coefficient of population size is 0.000015 (near zero) with a corresponding asymptotic probability value of 0.020 that signifies a statistical significance at the 5 percent level. The coefficient of IGR is near zero as well. These results show that IGR as proxy for urbanization has a negative, significant but small effect on Covid-19 mortality. Also as expected, distance to epicenter has a negative effect on mortality albeit the effect is very small and weak. Population size seems to have a positive and strong effect on mortality at the 5 percent level of significance, but the size of the effect is marginal. Similarly, the effect of population density is positive but small and insignificant. The IGR as an indicator of economic activity seems to have a positive, small but statistically weak effect on mortality, while locations with high poverty and deprivation are associated with low mortality rates.

While some of the coefficients in the mortality model conform to a priori expectations, they do not warrant much discussion as their effects is either small or statistically not significant. This is perhaps because of the low rate of Covid-19 mortality in Nigeria, since most infected cases have been reported to recover eventually. Thus, comparing the Covid-19 infection model against that of mortality, it is plausible to suggest that the model of Covid-19 infection does better than the model of fatality, not just on the basis of causal effects but also in terms of fit. The R^2 value of the infection model is 0.9591 while that of the mortality model is 0.8636. While both have a good fit, the model of infection seems to be more robust.

In summary, the results presented above suggest that infections are driven largely by spatial forces such as distance from epicenter, business environment and inequality, while the most important driver of mortality is within-state inequality. Distance from epicenter though negative as expected, is only large and significant in the case of infections (Distance could accelerate the infection but not mortality). This suggests that locations within close proximity to the epicenter are on average more vulnerable to Covid-19 spread. Also evident from the study is that states with resilient business environments are less vulnerable to Covid-19 contagion compared to those with higher fragility. Another important finding is that states with high rates of inequality will tend to have high infection and mortality rates. One implication is that Covid policy responses in Nigeria should aim at curtailing infections based on differences in geographical distance to epicenters, business environment,

Online ISSN 2412-0731

and inequality as the key drivers and risk factors of Covid-19 across the states. The caveat is that our conclusions are based on the coefficients with simultaneously large and statistically significant effects on Covid-19 infection.

Conclusion

This paper interrogates the socioeconomic factors that drive Covid-19 pandemic in Nigeria based on state-level cross-sectional data. Using a pooled multivariate regression model of infection and mortality, the analysis narrows the spread of Covid-19 to three key drivers encapsulating the core measures of geographical proximity, resilience, and income distribution. The results point to proximity, resilience, and inequality as the most important drivers of Covid-19 in Nigeria. These have very important policy implication in terms of choosing the optimal policy response to minimize the adverse effects of the pandemic on the economy of Nigeria. The results are in line with the finding in Stojkoski et al. (2020), and that of Gupta et al. (2021) which posits that policy responses that ignore underlying vulnerabilities would only serve to exacerbate underlying inequalities.

The analysis in this paper suggests that Covid-19 infections tend to be lower the farther away from epicenters and in states with high quality business environment but could be driven up by higher income inequality. One implication is that policy responses in Nigeria should aim at curtailing infections based on state-specific differences in terms of geographical distance to the epicenter, business environment, and inequality as some of the key drivers and risk factors of Covid-19 across the states. For optimal policy responses, state-specific, as opposed to uniform measures, should be encouraged. For example, temporary lockdown policy in the epicenter and neighboring states can lessen the overall economic costs of the pandemic in Nigeria. Similarly, lockdown measures may be eased in states with high business resilience while rolling out palliatives in states with high rates of inequality can even out the adverse effects of stay-at-home measures.

References

Adda, J. (2016). Economic activity and the spread of viral diseases: Evidence from high frequency data. *Quarterly Journal of Economics*, *131*(2), 891–941. https://doi.org/10.1093/qje/qjw005

Ainsworth, M., & Dayton, J. (2003). The impact of the AIDS epidemic on the health of older persons in Northwestern Tanzania. *World Development*, *31*(1), 131–148. https://doi.org/10.1016/S0305-750X(02)00150-X

Ajibo, H. (2020). Effect of Covid-19 on Nigerian Socio-economic Well-being, Health Sector Pandemic Preparedness and the Role of Nigerian Social Workers in the War Against Covid-19. *Social Work in Public Health*, Vol. 35(7), pp. 511-522. https://doi.org/10.1080/19371918.2020.1806168

Aron, J., & Muellbauer, J. (2022). Excess Mortality Versus COVID-19 Death Rates: A Spatial Analysis of Socioeconomic Disparities and Political Allegiance Across U.S. States. *Review of Income and Wealth*, *68*(2), 348–392. https://doi.org/10.1111/roiw.12570

Billingsley, S., Brandén, M., Aradhya, S., Drefahl, S., Andersson, G., & Mussino, E. (2022). COVID-19 mortality across occupations and secondary risks for elderly individuals in the household: A population register-based study. *Scandinavian Journal of Work, Environment & Health*, *48*(1), 52–60. https://doi.org/10.5271/sjweh.3992

Braga, A. L. F., Zanobetti, A., & Schwartz, J. (2002). The effect of weather on respiratory and cardiovascular deaths in 12 U.S. cities. *Environmental Health Perspectives*, *110*(9), 859–863. https://doi.org/10.1289/ehp.02110859

Buja, A., Paganini, M., Cocchio, S., Scioni, M., Rebba, V., & Baldo, V. (2020). Demographic and socio-economic factors, and healthcare resource indicators associated with the rapid spread of COVID-19 in Northern Italy: An ecological study. *PLoS ONE*, *15*(12 December). https://doi.org/10.1371/journal.pone.0244535

Chatters, L. (2010). Public health research and practice in Africa. *Journal of Public Health in Africa*, *1*(21), 335–367. https://doi.org/10.4081/jphia.2010.e1

Clay, K., Lewis, J., & Severnini, E. (2018). *Pollution, Infectious Disease, and Mortality: Evidence from the 1918 Spanish Influenza Pandemic. The Journal of Economic History, 78*(4), 1179-1209. doi:10.1017/S002205071800058X

Online ISSN 2412-0731

Ehlert, A. (2021). The socio-economic determinants of COVID-19: A spatial analysis of German county level data. In *Socio-Economic Planning Sciences78(101083)*. https://doi.org/10.1016/j.seps.2021.101083

Folland, S. (2008). An economic model of social capital and health. *Health Economics, Policy and Law*, *3*(4), 333–348. https://doi.org/10.1017/S1744133108004532

Gardner, W., States, D., & Bagley, N. (2020). The Coronavirus and the Risks to the Elderly in Long-Term Care. In *Journal of Aging and Social Policy* (Vol. 32, Issues 4–5, pp. 310–315). https://doi.org/10.1080/08959420.2020.1750543

Grekousis, G., Lu, Y., & Wang, R. (2022). Exploring the socioeconomic drivers of COVID-19 mortality across various spatial regimes. *The Geographical Journal*, *188*(2), 245–260. https://doi.org/10.1111/geoj.12436

Gupta, J., Bavinck, M., Ros-Tonen, M., Asubonteng, K., Bosch, H., Van Ewijk, E., Hordijk, M., Van Leynseele, Y., Lopes Cardozo, M., Miedema, E., Pouw, N., Rammelt, C., Scholtens, J., Vegelin, C., & Verrest, H. (2021). COVID-19, poverty and inclusive development. *World Development*, *145*(105527), 1–13. https://doi.org/10.1016/j.worlddev.2021.105527

He, Y., Seminara, P. J., Huang, X., Yang, D., Fang, F., & Song, C. (2023). Geospatial Modeling of Health, Socioeconomic, Demographic, and Environmental Factors with COVID-19 Incidence Rate in Arkansas, US. *ISPRS International Journal of Geo-Information*, *12*(2), 45. https://doi.org/10.3390/ijgi12020045

ILO. (2020). *COVID-19 and the World of Work: Impact and Policy Responses*. Geneva, Switzerland. 1-23

Jain, V., & Singh, L. (2020). Global Spread and Socio-Economic Determinants of Covid-19 Pandemic. In *Seoul Journal of Economics*, 33 (4), 1-40. https://doi.org/10.22904/sje.2020.33.4.004

Koc, İ., & Sarac, M. (2020). Socio-economic, demographic and health determinants of the Coronavirus pandemic: Analysis of data from OECD countries. *Turk J Public Health*, 18(Spcial issue), 1–13. https://doi.org/10.20518/tjph.721921

Nagano, H., Puppim de Oliveira, J. A., Barros, A. K., & Costa Junior, A. da S. (2020). The 'Heart Kuznets Curve'? Understanding the relations between economic development and cardiac conditions. *World Development*, *132:104953*.1-12 https://doi.org/10.1016/j.worlddev.2020.104953

Perone, G. (2021). The determinants of COVID-19 case fatality rate (CFR) in the Italian regions and provinces: An analysis of environmental, demographic, and healthcare factors. *Science of the Total Environment*, *755(1)*. 1-11 https://doi.org/10.1016/j.scitotenv.2020.142523

Qiu, Y., Chen, X., & Shi, W. (2020). Impacts of social and economic factors on the transmission of coronavirus disease 2019 (COVID-19) in China. *Journal of Population Economics*, *33*(4), 1127–1172. https://doi.org/10.1007/s00148-020-00778-2

Sá, F. (2020). Socioeconomic Determinants of COVID-19 Infections and Mortality: Evidence from England and Wales. In *CEPR Discussion Paper* (Issue 159).1-15

Sannigrahi, S., Pilla, F., Basu, B., Basu, A. S., & Molter, A. (2020). Examining the association between socio-demographic composition and COVID-19 fatalities in the European region using spatial regression approach. *Sustainable Cities and Society*, *62:102418*. 1-14. https://doi.org/10.1016/j.scs.2020.102418

Sigler, T., Mahmuda, S., Kimpton, A., Loginova, J., Wohland, P., Charles-Edwards, E., & Corcoran, J. (2021). The socio-spatial determinants of COVID-19 diffusion: The impact of globalisation, settlement characteristics and population. *Globalization and Health*, *17*(1), 1–14. https://doi.org/10.1186/s12992-021-00707-2

Stojkoski, V., Utkovski, Z., Jolakoski, P., Tevdovski, D., & Kocarev, L. (2020). The Socio-Economic Determinants of the Coronavirus Disease (COVID-19) Pandemic. *SSRN Electronic Journal*. 1-30. https://doi.org/10.2139/ssrn.3576037

Strauss, J., Thomas, D., Strauss, J., & Thomas, D. (1998). *Health, Nutrition, and Economic Development*. *36*(2), 766–817.

Tanne, J. H., Hayasaki, E., Zastrow, M., Pulla, P., Smith, P., & Rada, A. G. (2020). Covid-19: How doctors and healthcare systems are tackling coronavirus worldwide. *BMJ (Clinical Research)*, 368 (1090). https://doi.org/10.1136/bmj.m1090

Online ISSN 2412-0731

Wallinga, J., Teunis, P., & Kretzschmar, M. (2006). Using data on social contacts to estimate age-specific transmission parameters for respiratory-spread infectious agents. *American Journal of Epidemiology*, *164*(10), 936–944. https://doi.org/10.1093/aje/kwj317

Wu, X., Nethery, R. C., Sabath, M. B., Braun, D., & Dominici, F. (2020). Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study. *Science Advances*. 1-36. https://doi.org/10.1101/2020.04.05.20054502

Zanakis, S. H., Alvarez, C., & Li, V. (2007). Socio-economic determinants of HIV/AIDS pandemic and nations efficiencies. *European Journal of Operational Research*, *176*(3), 1811–1838. https://doi.org/10.1016/j.ejor.2005.10.033

Information about the authors

Ismail Hayatu Sanusi — Lecturer and PhD Fellow, Department of Economics, Ahmadu Bello University (Zaria, Nigeria)**;** ORCID: 0000-0002-7252-2129; e-mail: isfahis@gmail.com

Jamilu Said Babangida — Lecturer, Department of Economics, Ahmadu Bello University (Zaria, Nigeria); PhD Fellow, Department of Economics, Yildiz Technical University (Istanbul, Turkiye) ; ORCID: 0000-0002-7178-0978; e-mail: jsbabangida@gmail.com

ARTICLE INFO: received April 5, 2023; accepted September 3, 2023

Информация об авторах

Сануси Исмаил Хаяту – преподаватель и аспирант, кафедра экономики, Университет Ахмаду Белло (Зария, Нигерия); ORCID: 0000-0002-7252-2129; e-mail: isfahis@gmail.com

Бабангида Джамилу Саид – преподаватель, кафедра экономики, Университет Ахмаду Белло (Зария, Нигерия); аспирант, кафедра экономики, Технический университет Йылдыз (Стамбул, Турция); ORCID: 0000-0002-7178-0978; e-mail: jsbabangida@gmail.com

ИНФОРМАЦИЯ О СТАТЬЕ: дата поступления 5 апреля 2023 г.; дата принятия к печати 3 сентября 2023

作者信息

萨努西•伊斯梅尔•哈亚图——讲师、在读博士，经济系，艾哈迈杜·贝洛大学（扎里亚，尼日利亚）；ORCID: 0000-0002-7252-2129; 邮箱：isfahis@gmail.com

巴班吉达•贾米卢•赛义德——讲师，经济系，艾哈迈杜·贝洛大学（扎里亚，尼日利亚）；经济系在读博士，耶尔德兹技术大学（伊斯坦布尔，土耳其）；ORCID: 0000-0002-7178-0978; 邮箱：jsbabangida@gmail.com

Online ISSN 2412-0731