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Article

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Comparative Economic Research. Central and Eastern Europe

Provided in Cooperation with:

Institute of Economics, University of Łódź

Suggested Citation: Aderounmu, Busayo; Awofiranye, Adedoyin; Oni, Olubusayo Emmanuel (2023) : Environmental quality, infant morality, and economic growth in selected sub-Saharan African countries, Comparative Economic Research. Central and Eastern Europe, ISSN 2082-6737, Lodz University Press, Lodz, Vol. 26, Iss. 2, pp. 149-162, <https://doi.org/10.18778/1508-2008.26.17>

This Version is available at:

<https://hdl.handle.net/10419/289740>

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Environmental Quality, Infant Mortality, and Economic Growth in Selected Sub-Saharan African Countries

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Abstract

Beyond the usual macroeconomic stability, which is a necessity for economic growth, more focus should be placed on the effects that environmental quality has on infant mortality in sub-Saharan Africa. Africa has always had the highest rate of infant mortality and the poorest environmental quality in the world. High infant mortality shows that there are unmet human needs and unenforced policies to protect the environment. Therefore, this research examines the impact of environmental quality on infant mortality and how environmental quality and infant mortality also affect economic growth using 15 selected sub-Saharan African countries for a period of 10 years (2010–2019). The study employed fixed and random effects methods of estimation. The results showed that environmental quality has a significant negative (51.53%) impact on infant mortality and that economic growth also has a negative (45.58%) impact on infant mortality. The study recommends that governments should increase expenditure on health, with more focus on financing infant healthcare, because it also affects economic growth.

Keywords: Environmental quality, infant mortality, economic growth, sub-Saharan African

JEL: O44, I15, N17, Q53



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Received: 4.10.2022. Verified: 30.11.2022. Accepted: 8.03.2023

Introduction

At the earliest stage of infant life, everything must be close to perfect in temperature, food, and environment for proper growth and development. However, many factors are often ignored regarding children's well-being, including pollution, climate, and clean water, among other things (Salthammer et al. 2016). Pollution is one of the most common factors that have a negative effect on infant mortality and other health-threatening diseases. This assertion was proven by Singh et al. (2019), whose analysis showed that air pollution causes birthing complications such as stunted growth and underweight babies. This implies that as bad as these ailments may seem to be, threatening children's lives, there is a more significant problem from which they stem, and that is the issue of bad environmental quality (Osabohien et al. 2021; Alege, Adediran, and Ogundipe 2016).

The environment begins to affect a baby from the womb (Gilliland et al. 2002). This is because children are more susceptible to sicknesses and diseases, especially those that stem from their environment. Exposure to prolonged negative weather conditions and weather shocks (like drought) in infancy and early childhood affects infant mortality (Andriano and Monden 2017; Urhie et al. 2020).

From raging fires all over Europe to rising sea levels, floods, and heatwaves in most parts of Africa, the globe is becoming increasingly conscious of environmental quality and climate change, and the global economy is growing increasingly concerned about these issues. The air quality in Africa gets worse daily due to various air pollutants, such as exhaust fumes from vehicles and industrial gas. Bourzac (2019) estimates that about 780,000 deaths are caused by air pollution in African countries every year.

Africa is the second most populated continent in the world, after Asia (Statista 2020). It is also the continent with the highest infant mortality rate, with 76 deaths per 1000 live births (UNICEF 2020). In 2019, 5.2 million children under the age of 5 died worldwide, and over half of those deaths were recorded in Sub-Saharan Africa. The continent faces the problem of balancing energy demands in the global economy and examining climate change issues. In previous years, sub-Saharan Africa experienced worse cases of infant and child mortality related to malaria and malnutrition, although total infant mortality has been declining. This is attributed to the low coping capacities of countries to climate change issues (United Nations 2020).

Thus, Africa needs to examine ways to implement its policies effectively to prevent and reduce the effect of carbon emissions, which is the main reason behind climate change. Some consequences in the region could include rising sea levels, rising temperatures, irregular rainfalls, and extreme weather events. This could then result in general issues that are prejudicial to health, like respiratory conditions, skin cancer, high blood pressure, malnutrition, and malaria (World Health Organization 2015).

However, there is little to no literature on the effects of environmental quality on infant mortality in Sub-Saharan Africa. This research seeks to add to the body of knowledge in this area. From a review of previous articles, this study examines the effects of environmental quality and economic growth on infant mortality in Sub-Saharan Africa. It also investigates the effect of economic growth on infant mortality and environmental quality.

This paper is divided into five sections. Following the introductory section, section two reviews some relevant literature. The methodology for the study is discussed in section three, while section four discusses the result and findings. Section five provides the conclusion and recommendations.

Literature review

Children breathe in twice as much air as adults. They also have weaker immune systems, so their lungs are much more vulnerable and susceptible to diseases. Urban children are at risk due to living close to industrial sites, but children in rural areas seem to be the most at risk. The number of children at risk is expected to increase if action is not taken.

According to Bannister and Zhang (2005), child mortality is affected to a large extent by economic growth. Their study investigates the determinants of China's mortality levels and trends since 1981, and they found that if economic growth rises, standards of living increase and child mortality declines. If per capita income increases, individuals can afford better health care, which leads to higher life expectancy. Good health care coupled with higher life expectancy will lead to progressive economic growth.

Lower and middle-income countries face a threat to women and children stemming from indoor air pollution from sources like solid fuels for cooking (Aigbokhaode and Isara 2021). In Myanmar, data were collected during the first demographic and health survey conducted in 2016 to investigate the extent to which indoor air pollution affects the mortality of newborns, infants, and children under five years of age. The data showed that the prevalence of Solid Fuel Use (SFU) was 79%, and the mortality ratio per 1000 live births was 26, 45, and 49 in newborns, infants, and children under five years, respectively. Compared to the odds of mortality in households that do not use solid fuels, households that use solid fuels had a relatively higher mortality rate in children.

Quy-Toan, Joshi, and Stolper (2016) provide a link between industrial pollution and infant mortality, with the case study narrowed to pollution in the River Ganges. The logic explains that a nursing mother who bathes with polluted water is most likely to transfer it to the baby. This showed a link between infant mortality and river pollution. Although environmental policies helped to reduce pollution in India, there is still a long

way to go. The reason for the lack of improvements in environmental quality is the high marginal cost associated with pollution control.

Alege and Ogundipe (2013) established a relationship between economic growth and environmental pollution, showing how an increase in income could lead to poor economic performance. Recent improvements in the standard of living have been at the expense of the environment. They have contributed to environmental pollution through the increase in noise due to development, smoke from cars and transport systems, deforestation, and the burning of bushes, among other things. All these challenges come with development, but they can be managed. Increased growth tends to improve productivity and technical capacity in the nation. The need to increase production capacity rises to allow larger production volumes at lower rates of environmental degradation. The advancement in technological capacity, as well as the need to employ more labor, will eventually create more opportunities and bring about huge investments in new and upcoming technologies; this can help solve the problem of waste.

Carbon, which is one of the major causes of environmental pollution, has been observed to be related to economic growth in certain emerging economies. Carbon emissions appear to be falling in high-income nations, although it seems not to be the case in some emerging economies like China, Brazil, or Egypt. According to one study, economic growth propels pollution, but if this growth is sustained for a longer period, there could be a decline in pollution. This is because, with time, technology would have improved in certain areas and would help curb the effect and causes of pollution in those areas. A way to tackle carbon driven environmental pollution is by creating policies that regulate the number of carbon-intensive products that are imported into the country and observe the activities of huge companies that could be contributing massively to this problem (Alege and Ogundipe 2013).

Patel et al. (2018) investigated the relationship between environmental quality and infant mortality in the United States and discovered that there are high infant mortality rates with large ethnic or racial disparities. By obtaining linked birth and infant death data from the U.S. Centers for Disease Control and Prevention, five ethnic/racial groups were identified to examine the differences by race/ethnicity. In that study, conducted between 2000 and 2005, 144,741 infants died out of a total of 22,702,529, which is 6.4 infant deaths per 1000 live births. The results showed that there was less likelihood of mortality among infants of non-Hispanic white mothers, while the likelihood increased in infants of Non-Hispanic black mothers. (Patel et al. 2018).

The highest child mortality rate is in Sub-Saharan Africa, with about 92 deaths per 1,000 live births in 2013. We combined individual-level data from 83 Demographic and Health Surveys from 33 countries in Sub-Saharan Africa, paying attention to local rainfall information and temperature change, to ascertain the determi-

nants of child mortality. Exposure to adverse weather conditions, such as drought, at the early stages of life affects child mortality because of vulnerability to malaria and malnutrition, as well as other harmful diseases. Sub-Saharan Africa is the region hardest hit by climate change, and it is most likely going to experience far more extreme weather conditions in the future. We combined individual-level data with data on rainfall and temperature variations to study the anomalies in these factors and determine if maternal education can mitigate the effects of environmental changes on infants. The results suggest that climate shocks increase the risk of child mortality, while maternal education can mitigate the effects (Andriano and Monden 2017).

Rahman, Alam, and Khanam (2022) examined the socio-economic factors affecting high infant and child mortality rate in selected African countries using panel corrected standard error, feasible generalized least square models and pair-wise granger causality test. The result of the study shows that public health expenditure, number of physicians, globalization, economic development, education and good governance negatively affect the infant and child mortality rates.

Adeleye et al. (2022) examined the nexus among mortality rate, carbon emission, renewable energy and per capita income in 47 selected sub-Saharan African countries between 2005 to 2019 using generalized method of moments. The result of the study shows that carbon emissions and renewable energy increase mortality rate while per capita income reduces infant mortality rate.

Methodology

Infant mortality is a very important variable to be studied in any economy. If infant mortality is very high, the chances of growth are very low. This study is based on the modernization theory, which claims that infant mortality will fall because of industrialization due to the positive things that come with economic development, such as improvements in the medical sector, environmental policies, and education systems, among other things (Frey and Cui 2017).

This research focused on 15 countries in Sub-Saharan Africa: the Central African Republic, Sierra Leone, Nigeria, Chad, Lesotho, the Democratic Republic of Congo, Guinea, Liberia, Mali, Benin, Cote D'Ivoire, Mozambique, Burkina Faso, Guinea-Bissau, and Cameroon. They have the highest infant mortality rates and are also among the International Development Association (IDA) countries. The study used secondary data covering a period of 10 years, from 2010 to 2019. This data was sourced from World Development Indicators (WDI). For the analysis, the panel unit root test was conducted, followed by panel fixed and random effect models, taking into consideration the Hausman effect.

This study adapts the works of Mutizwa and Makochekekanwa (2015), who explained the impact of environmental factors on health outcomes by using the following model:

$$\ln INF_{it} = \beta_o + \beta_1 \ln CO_{it} + \beta_2 \ln AS_{it} + \beta_3 \ln AW_{it} + F_i + e_{it},$$

where infant mortality rate (INF) is dependent on variables such as carbon emission (CO), access to sanitary facilities (AS), and improved water sources (AW).

Infant mortality is also dependent on environmental factors: Carbon emissions, economic growth, population, environmental policy, and gross domestic product. Therefore, the general model for the study is expressed thus:

$$INF = f(CO_2, APM, EVP, PGA, GDP), \quad (1)$$

where: INF = Infant Mortality, CO₂ = Carbon Emissions, APM = Air pollution, EVP = Policy and Institutions for Environmental Sustainability Rating, PGA = Annual growth of population, GDP = Gross Domestic Product.

Equation (2) is an econometric model:

$$INF_{ct} = \beta_o + \beta_1 CO_{2ct} + \beta_2 LAPM_{ct} + \beta_3 EVP_{ct} + \beta_4 PGA_{ct} + \beta_5 LGDP_{ct} + \mu_{ct}, \quad (2)$$

where: β_o = Constant, β_1, \dots, β_5 = Coefficient of independent variables, L = Natural log, μ = Error Term, c = countries, t = time.

This study further examines the impact of economic growth on infant mortality and environmental quality. This objective was achieved using the following equations:

$$INF_{ct} = \beta_{0ct} + \beta_{1ct} LGDP_{ct} + \beta_{2ct} PGA_{ct} + \beta_{3ct} GEH_{ct}, \quad (3)$$

$$CO_{2ct} = \beta_{0ct} + \beta_{1ct} LGDP_{ct} + \beta_{2ct} PGA_{ct} + \beta_{3ct} PAE_{ct}, \quad (4)$$

where: INF = Infant Mortality, CO₂ = Carbon Emissions, PGA = Annual growth of population, GDP = Natural log of Gross Domestic Product, GEH = Government expenditure on health, PAE = Population with access to electricity.

Table 1. Definition and sources of data

Variable	Definition	Source
Infant Mortality (INF)	Infant mortality is the number of children that die between the ages of 0 and 1, as expressed per 1000 live births.	World Development Indicators (WDI), World Bank, 2020
Carbon Emission (CO ₂)	Carbon emission is the release of excess amounts of the harmful gas carbon dioxide into the atmosphere, especially through deliberate human actions.	World Development Indicators (WDI), World Bank, 2020
Gross Domestic Product (GDP)	This is the total cost of all finished goods and services produced in a country over a given period, usually a year.	World Development Indicators (WDI), World Bank, 2019
Annual Growth of Population (%) (AGP)	Annual growth of population refers to the rate of change in population size for a given country or geographical area during a specific period which, in this case, is a year.	World Development Indicators (WDI), World Bank, 2019
Air Pollution (Micrograms per Cubic Meter) (APM)	This is the average level of exposure of a country's population to suspended particle concentrations less than 2.5 microns in aerodynamic dimension.	World Development Indicators (WDI), World Bank, 2020
Government Expenditure on Health (% of GDP) (GEH)	Government expenditure on healthcare is the amount of money allocated to the healthcare sector of the country per year.	World Development Indicators (WDI), World Bank, 2020
Policy And Institutions for Environmental Sustainability Rating (EVP)	The extent to which institutions for environmental sustainability assess environmental policies that promote the protection and sustainable use of natural resources, as well as pollution control. This rating ranges from 1 to 6, with one being the lowest (bad) and 6 being the highest (good).	World Development Indicators (WDI), World Bank, 2020
Population with Access to Electricity (%) (PAE)	Population with access to electricity is the data that shows the percentage of the population who have access to electricity.	World Development Indicators (WDI), World Bank, 2020

Source: authors' compilation.

Result and discussion

The study employed panel random and fixed effects methods of analysis. Table 2 shows the result of the panel fixed and random effects for the effect of environmental quality and economic growth on infant mortality. Based on the results of the Hausman test, the results interpreted are the results of the fixed-effects model. The model has a goodness of fit represented by the R^2 of 90.6% and an adjusted R^2 of 89.2%, which accounts for the degree of freedom. The R^2 indicates that carbon dioxide emission, air pollution, environmental policy rating, annual population growth, and GDP account

for 90.6% of variations in infant mortality. The probability of the F-statistic is below 0.05, which indicates that the variables in the model are jointly significant.

Table 2. Effect of environmental quality and economic growth on infant mortality

Dependent variable: Infant mortality	Fixed effect		Random effect	
	Variables	coefficient	p-value	coefficient
C _{o2}	0.0005	0.0028	0.0002	0.0154
LAPM	- 51.5379	0.0000	- 39.1131	0.0000
EVP	1.8301	0.2466	- 3.5159	0.0123
PGA	- 1.3618	0.4404	0.0755	0.9622
LGDP	- 39.9826	0.0000	- 17.7260	0.0000
C	561.218	0.0000	323.5729	0.0000
R ²	0.9062		0.3291	
Adjusted R ²	0.8926		0.30580	
F-Statistics	66.1389	0.0000	14.12678	0.0000

Source: authors' compilation.

The coefficient of carbon dioxide emissions is statistically significant. There is a positive relationship between carbon dioxide emissions and infant mortality. This means that when carbon dioxide increases by one unit, infant mortality will increase by 0.0005 units. That is, when carbon dioxide increases by one kiloton, infant mortality will increase by 0.5 per 1000 live births. The coefficient of air pollution is statistically significant. There is a negative relationship between air pollution and infant mortality. This means that when air pollution increases by one unit, infant mortality will decrease by 51.54 units.

The coefficient of GDP is statistically significant. There is a negative relationship between GDP and infant mortality. This means that when GDP increases by one unit, infant mortality will decrease by 39.98 units. That is, when GDP increases by a dollar, infant mortality will decrease by approximately 40 per 1000 live births. Environmental policy ratings and the annual population growth are the variables that are not statistically significant in the model, as they all have p-values that are greater than 0.05.

To examine the effect of economic growth on infant mortality and environmental quality, Table 3 and 4 shows the result of the fixed and random effect analysis. Based on the results of the Hausman test, the results interpreted are the results of the fixed-effects model.

Table 3. Effect of economic growth on infant mortality

Dependent variable: infant mortality	Fixed effect		Random effect	
	Variables	coefficient	p-value	coefficient
LGDP	-45.58	0.0000	-23.40444	0.0000
PGA	3.5547	0.0759	2.915941	0.0939
GEH	-1.4170	0.0000	-1.335828	0.0000
C	534.3866	0.0000	312.8701	0.0000
R ²	0.8910		0.2649	
Adjusted R ²	0.8770		0.2498	
F-Statistics	63.4903	0.0000	17.5379	0.0000

Source: authors' compilation.

The model has a goodness of fit represented by the R² of 89.1% and an adjusted R² of 87.7%, which accounts for the degree of freedom. The R² indicates that GDP, Annual population growth, and government expenditure on health account for 89.1% of variations in infant mortality. The probability of the F-statistic is below 0.05, which indicates that the variables in the model are jointly significant.

The coefficient of GDP is statistically significant. There is a negative relationship between GDP and infant mortality. This means that when GDP increases by one unit, infant mortality will decrease by 45.58 units. That is, when GDP increases by a dollar, infant mortality will decrease by 45.58 per 1000 live birth.

The coefficient of government health expenditure is statistically significant. There is a negative relationship between government health expenditure and infant mortality. This suggests that a one-unit increase in government health spending will result in a 1.42-unit reduction in infant mortality. That is, for every 1% increase in government health spending, infant mortality falls by 1.42 per thousand live births.

Table 4. Effect of economic growth on environmental quality

Dependent variable: Carbon emission	Fixed effect		Random effect	
	Variables	coefficient	p-value	coefficient
LGDP	989.1684	0.0022	3278.79	0.1916
PGA	-137.6650	0.8761	-101.1947	0.9081
PAE	78.4002	0.0345	67.8252	0.0648
C	-543.9630	0.9830	-23310	0.3581

Dependent variable: Carbon emission	Fixed effect		Random effect	
	Variables	coefficient	p-value	coefficient
R ²	0.9963		0.0618	
Adjusted R ²	0.9959		0.0425	
F-Statistics	2090.998	0.0000	3.2052	0.0251

Source: authors' compilation.

Based on the results of the Hausman test, the results interpreted are the results of the fixed-effects model. The model has a goodness of fit represented by the R² of 99.6% and an adjusted R² of 99.5%, which accounts for the degree of freedom. The R² indicates that GDP, annual population growth, and population with access to electricity account for 99.6% of variations in infant mortality. The probability of the F-statistic is below 0.05, which indicates that the variables in the model are jointly significant.

The coefficient of GDP is statistically significant. There is a positive relationship between GDP and carbon dioxide emissions. This means that when GDP increases by one unit, carbon dioxide emission will increase by 989.17 units. The coefficient of the population with access to electricity is statistically significant. There is a positive relationship between population with access to electricity and carbon emission. This means that when the population with access to electricity increases by one unit, carbon dioxide emission will increase by 78.40. That is, when the population with access to electricity increases by one percent, environmental quality represented by carbon emission will increase by 78.40.

Discussion and implication of findings

This study was carried out to determine if environmental quality affects infant mortality in selected sub-Saharan African countries. From the results, all variables met the *a priori* expectations. This means that for most countries in sub-Saharan Africa, carbon affects infant mortality. To reduce infant mortality, it will have to be measured to keep the environmental quality high. The results are supported by the findings of various previous studies. In different countries and regions, the findings still hold, e.g., Jayachandran (2009), Aguilera et al. (2013), Pullabhotla (2018), Anwar et al. (2019), and Singh et al. (2019) show that there is a positive relationship between infant mortality and environmental quality.

This study also showed that infant mortality has a negative effect on economic growth. This also aligns with previous studies. The study found that GDP is significant and negatively related to infant mortality. This explains that if infant mortality

ty is effectively managed and kept at a minimum, there will be higher levels of economic growth. This study found that government expenditure on health negatively affects infant mortality. As the government increases expenditure in the healthcare sector, it allows for better medical care, reducing infant mortality.

This study found that carbon emissions are positively related to economic growth. As the economy and GDP grow, there will be more carbon dioxide emissions. This happens as economic growth brings about industrialization, which leads to carbon dioxide emissions. This was part of the implications of the environmental Kuznets curve.

This study shows that environmental quality significantly impacts infant mortality. Therefore, to reduce infant mortality, environmental quality should be addressed seriously. This study has also shown that environmental quality and infant mortality growth impact economic growth. Therefore, attempts should be made to keep these variables at a minimum. Actions could include greater investment in health and more environmental policies to promote environmental sustainability.

Conclusion

The study covered the relationship between environmental quality and infant mortality in selected sub-Saharan African countries from 2010 to 2019. It showed that the quality of the environment influences infant mortality. It is, therefore, necessary to improve the quality of the environment by reducing the level of air pollution and carbon emission in the atmosphere. Infant mortality is a problem that should be tackled because this study showed that infant mortality has a negative impact on economic growth. It leads to the loss of potential human capital.

Acknowledgments

The authors are using this medium to appreciate the Covenant University Centre for Research, Innovation and Discovery (CUCRID) for the publication support provided for this article. We also acknowledge the authors of the paper cited in this research work.

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Jakość środowiska, śmiertelność niemowląt i wzrost gospodarczy w wybranych krajach Afryki Subsaharyjskiej

Obok zwykłej stabilności makroekonomicznej, która jest niezbędna dla wzrostu gospodarczego, elementem, na który należy zwrócić większą uwagę, jest wpływ jakości środowiska na śmiertelność niemowląt w Afryce Subsaharyjskiej. Afryka zawsze miała najwyższy wskaźnik śmiertelności niemowląt i najniższą jakość środowiska na świecie. Wysoka śmiertelność niemowląt pokazuje, że istnieją niezaspokojone potrzeby ludzkie i nieegzekwowana jest polityka ochrony środowiska. W związku z tym w niniejszym badaniu przeanalizowano wpływ jakości środowiska na śmiertelność niemowląt oraz wpływ jakości środowiska i śmiertelności niemowląt na wzrost gospodarczy na podstawie danych dla 15 wybranych krajów Afryki Subsaharyjskiej z okresu 10 lat (2010–2019). W badaniu zastosowano metody estymacji: efektów stałych i efektów losowych. Wyniki badania wykazały, że jakość środowiska ma znaczący negatywny wpływ (51,53%) na śmiertelność niemowląt. Wzrost gospodarczy ma również negatywny wpływ (45,58%) na śmiertelność niemowląt. Z opracowania wynika zalecenie, aby rządy zwiększyły wydatki na ochronę zdrowia, z większym naciskiem na finansowanie opieki zdrowotnej dla niemowląt, ponieważ wpływa to również na wzrost gospodarczy.

Słowa kluczowe: jakość środowiska, śmiertelność niemowląt, wzrost gospodarczy, Afryka Subsaharyjska