Senior Honors Theses and Projects   Honors College

2023

Ethnic fractionalization and health in West Africa

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Degree Type

Open Access Senior Honors Thesis

Department or School

Economics

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Subject Categories

Economics

ETHNIC FRACTIONALIZATION AND HEALTH IN WEST AFRICA

By

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A Senior Project Submitted to the

Eastern Michigan University

Honors College

In Partial Fulfillment of the Requirements for Graduation

with Departmental Honors in Economics

and with Highest Honors

Approved in Ypsilanti, MI on April 20, 2023

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Abstract

Artificial borders created during Africa's colonial era have had a lasting impact on the continent, specifically in relation to culture and ethnicity. This study investigates the relationship between ethnic diversity and health outcomes and health care infrastructure in West Africa. I explore the effects of ethnic fractionalization on various health outcomes such as life expectancy and mortality rates, health-related infrastructure and staffing, and disease and immunization levels. This paper will also discuss colonialism and its institutional legacy. The discussion of the findings will include the impact of ethnic fractionalization, GNI per capita, and foreign aid on these outcomes.

SECTION 1: INTRODUCTION

Africa's colonial history has had lasting impacts on modern Africa and must be considered when examining the quality of health. For decades external powers made their way into the continent in an effort to develop Africa. This only intensified exploitation of the peoples and resources. Artificial borders established during Africa's colonial era have had a lasting impact on the continent, specifically in relation to social outcomes including health infrastructure and health outcomes.

Traditionally, African societies and states functioned through an elaborate system based on the family, the lineage, the clan, the tribe, and ultimately a confederation of groups with common ethnic, cultural, and linguistic characteristics . These were the units of social, economic, and political organizations and inter-communal relations. The Cambridge Dictionary defines ethnicity as, "a large group of people with a shared culture, language, history, set of traditions, etc., or the fact of belonging to one of these groups." (Cambridge, 2023). Scholars generally agree that colonization encouraged Africans to rethink group identities and heightened a sense of socioeconomic and political competition along ethnic lines. There is also growing consensus that the politicization of ethnicity must be rooted in linguistic, cultural, and socioeconomic similarities and communal experiences of marginalization, neglect, injustice, and achievement (Lynch, 2018).

The desire to maintain national unity in the majority of African nations after independence served as the impetus for one-party rule, excessive power concentration, oppressive authoritarian regimes, and routine violations of basic rights and freedoms. These in turn have sparked a response, which has taken the form of increased conflict and the call for a second liberation. There has become a clear definition between ethnic majorities and minorities.

African states find it difficult to manage ethnic variety within the unity of colonial boundaries. The reluctance to face the tension has allowed disparities to persist and affect many aspects of life including health.

To that end, this study investigates the relationship between ethnic diversity and health outcomes in West Africa. In this study I use the United Nations definition of West Africa which includes, Benin, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

I examine the correlation between ethnic diversity and various health outcomes including life expectancy, mortality rates, health-related infrastructure and staffing, disease and immunization levels. In the sections that follow, section 2 will lay a brief cultural context discussing colonialism and its institutional legacy in West Africa. Section 3 will review literature on ethnicity and health outcomes both individually and concurrently. Section 4 describes the data used in this study. Section 5 describes the methodology. Section 6 provides results. Section 7 discusses the results and implications for West Africa. Section 8 concludes the paper and provides direction for future work.

SECTION 2: CULTURAL CONTEXT/INSTITUTIONAL DETAILS

West Africa is a region with a deep history of colonialism and imperialism. For this study I focus particularly on colonialism around the time of the Berlin conference beginning in 1884. The conference established legality that was acknowledged throughout the world. While this period is only a brief glimpse into Africa's history it has had a significant impact that Africa still feels the impacts of today.

Berlin Conference

The Berlin West Africa conference of 1884-1885 marked the legitimization of colonialism. The purpose of the conference was to manage the ongoing partition, or Scramble for Africa, to avoid conflict between colonial powers. In late 1884 German Chancellor Otto von Bismarck called a meeting of European powers in Berlin. In the subsequent meetings, Great Britain, France, Germany, Portugal, and Belgium, negotiated their claims to African territory, which were then formalized and mapped. During the conference the leaders also agreed to allow free trade among the colonies and established a framework for negotiating future European claims in Africa. Neither the Berlin Conference itself nor the framework for future negotiations provided any say for the peoples of Africa over the partitioning of their homelands (Oxford). Nor did they consider the geographic distribution of existing tribes or ethnicities when drawing these borders. The conference culminated with the ratification of a general act, or law, by major colonial powers (Nauwelaerte, 1966).

Colonization

After the Berlin Conference, European powers expanded quickly and intensely into Africa. By 1900, European states had claimed nearly 90 percent of African territory (Heath, 2010). In most parts of the continent, colonization lasted for a little over 70 years. These 70 years were a pivotal time in the global economy. As other countries and other parts of the world experienced great rates of industrialization and economic growth, Africa's position became more and more compromised politically, economically and militarily. European growth came at the expense of Africa. Europe fought over African countries, primarily for their wealth in natural resources, but also for religious and political reasons. By the 1900s, the majority of Africa had been colonized by seven European powers: Britain, France, Germany, Belgium, Spain, Portugal and Italy. Table 1 summarizes colonization in West Africa. These colonizers are discussed briefly in the following paragraphs.

The British were one of the most powerful colonizers in Africa. Britain's initial interest in West Africa was to have outposts for the slave trade. Britain passed abolition in 1807, which outlawed the slave trade so the interest in outposts declined. Interest in colonizing Africa arose again later in the 19th century around the time of the scramble for Africa, when Britain aggressively expanded their colonies. Modern day countries colonized by Britain include Gambia, Ghana, Sierra Leone, and Nigeria. The aim of British colonization was to introduce the three C's reported by David Livingstone to Africa. Those being Christianity, Commerce and Civilization (Nkomazana & Setume, 2016). In West Africa, the British were involved significantly with leaders of the nations they colonized. They ruled with an indirect system, where they allowed the leaders to rule people as they saw fit, but required they pay taxes to Britain. The British language, lifestyle, and religion were adopted. Many Africans from these

countries were educated in Britain. It is argued that, although British colonialism was disruptive to African culture and traditions, it was successful in the development of infrastructure, education and medical solutions (Austin, 2010).

The French were another powerful colonizer in Africa. They particularly focused their colonization in West Africa. The French were in Africa as early as the 1600s. During the industrial revolution the need for raw materials and manpower motivated them to pursue colonization in Africa. After the Berlin conference, France colonized African countries between 1890 and 1914. The modern day countries colonized by France in the west include Benin, Burkina Faso, Guinea, Ivory Coast, Mali, Mauritania, Niger, and Senegal. The French use a system of assimilation, aiming to transform all Africans into French. They imposed French culture, language, religion, law, traditions, lifestyle, and art in the areas they colonized in an effort to assimilate West African peoples. When the policy of assimilation was not very successful so the French introduced the policy of association, which is similar to indirect rule. The French policy of association shifted to recognizing pre-existing culture and political institutions of the colonies under them (Nyadzi, 2020).

Germany was a relative latecomer to colonialism in West Africa. They ended up with four protectorate territories, one of which is modern day Togo (Bechhaus-Gerst, 2012). Togoland was unique in that it lacked mineral resources. Rather than focus on mineral extraction like so many West African colonizers, Germany concentrated on harnessing the country's agricultural development. They took advantage of African labor and the climate, which is different from Germany, to grow crops well suited to the area, specifically cacao and cotton. Togoland was a German Empire protectorate in West Africa from until 1919. Togoland became independent as the Republic of Togo in 1960.

Portugal has a long history on the African continent. Portuguese sailors led the development of a route around unexplored Africa, Asia, and the East Indies in the 15th century. During their time of exploration, they established outposts in places that would later become their colonies. The Portuguese held a few small colonies in Africa. In the West they occupied present day Cape Verde and Guinea-Bissau. The Portuguese created colonies mainly to establish trade routes, to trade spices, gold, agricultural products, etc. They also created colonies to create more markets for Portuguese goods, spread Catholicism, and civilize native people in their selected countries. Guinea-Bissau was colonized in the 1500s. The Portuguese captured and enslaved many Bissau-Guineans and sent them to the New World. Additionally, they extracted gold and diamonds from the country. Guinea-Bissau gained independence in 1974 (Chabel, 1981). Post independence, the country was underdeveloped, and civil wars in the decades after independence took millions of lives. Cape Verde, a small island located off the western coast of Africa, was also colonized by the Portuguese. Cape Verde is said to have been "uninhabited" before the Portuguese arrived and were used in the slave trade. Cape Verde was the last country in the sample to achieve independence and achieved independence from Portugal in 1975.

Modern day Liberia was the only West African country to remain independent from Europe throughout the 1885 colonial period. However, the country was not completely free from external interference. Several countries, including Portugal and Britain, established trading posts in Liberia during the early 19th century. In 1821, the American Colonization Society (ACS) spearheaded the effort to create a colony on the coast. The intention of the settlement was to establish a place to relocate former slaves from the United States to Africa. The expatriated freed slaves became known as Americo-Liberians (Moulton, 2021). It was given the name Colony of Liberia in 1824. The colony achieved freedom in 1847, marking the founding of the Republic of

Liberia. Despite the establishment of this independent state, it remained widely recognized as a colony of the United States. Thus, the region was neglected during the African scramble.

Table 1: Brief Colonial History of West Africa

Country	Colonizer	Year Colonized	Independence Year
Benin	France	1904	1960
Burkina Faso	France	1896	1960
Cape Verde	Portugal	1462	1975
The Gambia	Britain	1821	1965
Ghana	Britain	1821	1957
Guinea	France	1893	1958
Guinea-Bissau	Portugal	1588	1974
Ivory Coast	France	1893	1960
Liberia	Independent	-	-
Mali	France	1892	1960
Mauritania	France	1895	1960
Niger	France	1900	1960
Nigeria	Britain	1900	1960
Senegal	France	1895	1960
Sierra Leone	Britain	1808	1961
Togo	Germany	1884	1919

Data from Author's research.

SECTION 3: LITERATURE REVIEW

There is growing literature discussing the implications of ethnic heterogeneity on a variety of outcomes. Numerous studies have examined the implication of ethnic heterogeneity on

outcomes including economic development, government quality, and production. Research looking specifically at the implications of ethnic heterogeneity on health outcomes is limited. This literature review will begin with the broader literature on the impact of ethnic heterogeneity on development.

Alesina and Zhuravskaya (2011) examine data on ethnic, linguistic, and religious composition at the subnational level across multiple countries, including some African countries. They find that ethnically and linguistically segregated countries tend to have a lower quality of government. They also find that there is no relationship between religious segregation and governance. La Porta et al. (1999) empirically examines the determinants of the quality of governments in a large cross-section of countries. One of the findings is that countries that are more ethno-linguistically heterogeneous exhibit inferior government performance.

Montalvo and Reynal-Querol (2005) look at the role that different indices and dimensions of ethnicity play in the process of economic development, and find higher levels of ethnic (religious) polarization has a large and negative effect on economic development through the reduction of investment and the increase of government consumption and the probability of a civil conflict.

Churchill, Okai, and Posso (2015) investigate the association between ethnic heterogeneity and information technology related outcomes such as internet access and internet use. They used data on a cross-section of eighty-five countries, and find evidence of a negative association between ethnic heterogeneity and the use of and access to the internet. In other words, countries with more ethnic diversity have less use and access to the internet. They conclude that cross-country differences in the global digital divide can be explained by the levels

of ethnic fractionalization. They also highlight other determinants of the digital divide including income, infrastructure, literacy level, level of urbanization and inequality.

The research examining the implications of ethnic heterogeneity on health outcomes is limited. Platas (2011) examined the effect of ethnic diversity on a broad range of health outcomes in a global sample of countries. She also looked at the impact by region and income level. This study placed particular emphasis on the sample of Sub-Saharan African countries. Platas finds that greater ethnic diversity is associated with poorer health outcomes, including higher infant and child mortality, and lower public health expenditure. Particularly within Africa, they find that variation in health outcomes is explained primarily by access to health facilities, as well as the quality of institutions. Additionally, Churchill, Exornam Ocloo, Siawor-Robertson (2016) examine a relationship between ethnic diversity and health outcomes. They then examine a cross-section of 91 countries and explore outcomes such as immunization rates, prevalence of diseases, life expectancy and mortality rates, and infrastructure and staff. Findings suggest that higher ethnic heterogeneity is associated with poorer health outcomes. The general findings they observed were consistent with the negative effects of ethnic and linguistic diversity on health.

This study adds to the body of knowledge around ethnic heterogeneity by focusing specifically on ethnic fractionalization in West Africa, which has its own precolonial history and history of colonization that differs from the experience of other regions of Africa.

SECTION 4: DATA

This study analyzes data from 16 countries: Benin, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo. The years covered in the sample are 1990-2013. Data are

collected from various sources to examine the effect of ethnic fractionalization on health outcomes. Ethnic fractionalization indices measure diversity as a steadily increasing function of the number of groups in a country (Drazanova, 2019).

Many factors may impact an individual's health. The World Health Organization (WHO) highlights three key broad overarching determinants of health: social and economic environment, physical environment, and a person's individual characteristics and behaviors (2008). The WHO established the Commission on Social Determinants of Health (CSDH) in 2005 to review and synthesize the social determinants of health into a single conceptual framework. The framework represents relationships among determinants that are based on scientific studies or substantial evidence and includes inputs to health such as education, income, ethnicity, etc.

The dependent variables in this model aim to encompass health outcomes. The health outcome variables examined are as follows: life expectancy, infant mortality, under 5 mortality, number of physicians, immunization rates, and HIV/AIDS Incidence. Summary statistics for these dependent variables can be found in table 2.

Table 2: Summary Statistics for Measures of Health

Health Variables				
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Life Expectancy (years)	54.85	6.49	36.69	75.06
Infant Mortality (per 1,000 live births)	84.48	30.18	19.20	177.80
Under 5 Mortality (per 1,000 live births)	142.20	56.90	22.50	329.60
Physicians (per 1,000 people)	0.11	0.12	0.01	0.60

| Immunization Rates (%) | 65.46 | 20.51 | 15 | 99 |
| HIV/AIDS Incidence | 20445 | 40085.74 | 41 | 188259 |

The life expectancy at birth variable is collected from the World Bank. It is measured in years and indicates the number of years a newborn infant would live if patterns of mortality at the time of its birth stayed the same throughout its life. This measure is a frequently used summary measure of overall health. Within these sample countries over the sample period average life expectancy is 54.85 years. Life expectancy ranges from 36.69 to 75.06 years.

All of the countries in the sample fall in the low or low middle income country categorization of the World Bank. The leading cause of death in low income countries is neonatal conditions. For lower middle income countries neonatal conditions are in the top three leading causes of death. Furthermore, in Africa as a whole, neonatal conditions are the leading cause of death. These findings prompted me to include infant mortality and under 5 mortality as measures of health for West Africa. Additionally these factors are especially sensitive to socioeconomic contexts.

Infant mortality rate is collected from the World Bank. It is the number of infants dying before reaching one year of age per 1,000 live births. Within this sample average infant mortality is 84.48 and ranges from 19.20 to 177.80. Under-five mortality rate is the probability per 1,000 live births that a newborn baby will die before reaching age five, if subject to age-specific mortality rates of the specified year. Within this sample average under-five mortality is 142.2 and ranges from 22.5 to 329.6. The key difference between infant mortality rate is it focuses on infants dying in the first year of life whereas under five also known as child mortality rate focuses on children who die between before age five.

To assess access to health care staffing and infrastructure, I include data on Physicians in West Africa. In their definition of Physicians, the World Bank includes generalist and specialist medical practitioners. Physicians are measured per 1,000 population. This factor speaks to the availability of healthcare personnel. Within this sample average number of physicians per 1,000 is 0.11 and ranges from 0.01 to 0.60.

The final two measures I use are measures of immunization and the incidence of AIDS. Specifically I look at diphtheria, pertussis (or whooping cough), and tetanus (DPT) immunizations amongst infants drawn from the World Bank. Child DPT immunization measures the percentage of children ages 12-23 months who received DPT vaccinations before 12 months. A child is considered adequately immunized against DPT after receiving three doses of vaccine. Within this sample, the average immunization rate is 65.46% with a range of 15% to 99%. Although this variable looks at an infant population, the vaccines impact everyone as diphtheria, tetanus, and pertussis can be spread from person to person (tetanus through wounds or cuts) and can have lasting negative health impacts sometimes culminating in death (CDC).

Another measure of health that I consider is HIV Incidence. This measures the number of new HIV infections among uninfected populations ages 15-49 expressed per 1,000 uninfected population in the prior year. It is collected from the World Bank database whose source was the Joint United Nations Programme on HIV/AIDS. It is challenging to collect direct measures of HIV incidence, therefore modeled estimates are used. While there have been many improvements in education and awareness around HIV/AIDS, Africa remains the continent most impacted by this disease. HIV/AIDS remains in the top five leading causes of death in Africa. HIV/AIDS is one factor that explains the average life-expectancy in sub-Saharan Africa being

54.4 years of age (Johnson, 2021). Within this sample, the average HIV incidence is 20,445 with a range of 41 to 188,259.

These dependent variables (life expectancy, infant and child mortality, number of physicians, DPT vaccination, and HIV/AIDS incidence) are intended to provide a snapshot of the health landscape within the countries in this region.

Within the model I aim to encompass the key country-level factors that are determinants of the country-level health outcomes and health infrastructure discussed above. The covariates on the right hand side of the model include: ethnic fractionalization, GNI Per Capita, female literacy, and US foreign aid. Summary statistics for these variables are in table 3.

Table 3: Summary Statistics for Covariates

Covariates				
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Ethnic Fractionalization	0.7595	0.10	0.43	0.89
GNI Per Capita (in dollars)	672.70	541.93	130	3310
School Life Expectancy (years)	1.83	1.19	0.41	5.74
US Foreign Aid (in dollars)	492,700,000	768,580,866	34,350,000	11,430,000,000

Ethnic fractionalization indices generally deal with the number, sizes, socioeconomic distribution, and geographical location of distinct cultural, linguistic, and/or religious groups. In this study I use Lenka Drazanova's Historical Index of Ethnic Fractionalization (HIEF) dataset (Drazanova, 2019). Introduced in 2019, Drazanova compiled annual ethnic fractionalization data

from 162 countries across all continents in the period of 1945–2013. Theoretically, this index

reflects the probability that two randomly selected people from a given country will belong to

different social or sub groups (Drazanova, 2019). Theoretically, the ethnic fractionalization index

ranges from 0, where there is no ethnic fractionalization in the country and all individuals are

members of the same ethnic group, to 1, where each individual in the country belongs to their

own ethnic group. HIEF builds on previous heterogeneity measures but brings in a time

component to depict longitudinal relationships and improve evaluation of causal relationships. It

is important to note the HIEF dataset is largely based on an ethnic, rather than linguistic,

distinction between groups (Drazanova, 2019). Additionally, there are many valid ways to

specify ethnicity in a country, and the "definition" of ethnicity has the potential to change over

time in a country. Within this sample the average ethnic fractionalization index is 0.7595 with a

range of 0.43 to 0.89.

GNI Per Capita is collected from the World Bank. GNI Per Capita is often used as a

measure of standard of living for the average citizen in a country. It is the Gross National

Income, the total amount of money earned by a country's businesses and individuals, divided by

the midyear population for a country measured in dollars and adjusted for the cost of living in

each country (purchasing power parity, PPP). The World Bank uses an Atlas method of

conversion to smooth fluctuations in prices in exchange rates. The Atlas method is the World

Bank's methodology of computing exchange rates to reduce the impact of market fluctuations in

the cross-country comparison of national incomes (World Health Organization, 2023). Within

this sample, the average GNI Per Capita is $672.70 with a range of $130 to $3310.

School life expectancy is the number of years a person of school entrance age can expect

to spend within the specified level of education (UNESCO Institute of Statistics). I include

school life expectancy because literature shows that higher education is correlated with high standard of living. Numerous studies have found a link between education and health outcomes (Zajacova & Lawrence, 2018). Generally, the more education one has the better their health outcomes. In this study I look specifically at school life expectancy from secondary school measured in years. This is the total number of years of schooling that a person in secondary school can expect to receive in the future. It is calculated as the sum of the age specific enrollment rates for the levels of education specified. The part of the enrolment that is not distributed by age is divided by the school-age population for the level of education they are enrolled in, and multiplied by the duration of that level of education. The result is then added to the sum of the age-specific enrollment rates. A relatively high SLE indicates greater probability for children to spend more years in education and higher overall retention within the education system (UNESCO). The measure aims to show the overall level of development of an educational system in terms of the average number of years of schooling that the education system offers to the eligible population, including those who never enter school.

This model also includes a measure of foreign aid Organization for Economic Co-operation and Development. Net Official Development Assistance (ODA) is aid that promotes and specifically targets the economic development and welfare of developing countries. I include ODA because assistance is given to development projects that impact health, such as clean water supply projects, irrigation projects, and construction of schools and hospitals. Aid may be provided bilaterally, from donor to recipient, or channeled through a multilateral development agency such as the United Nations or the World Bank. The foreign aid data used in this study are maintained by the OECD and are measured in current US dollars.

SECTION 5: METHODOLOGY

The aim of this study is to investigate the relationship between ethnic fractionalization and health outcomes in West Africa including life expectancy, infant mortality, under 5 mortality, physicians, immunization rates, HIV/AIDS Incidence. To evaluate the relationship I run the following OLS regression on panel data for each of the outcome variables discussed in the previous section:

$$y_{ct} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \delta_c + \delta_t + \varepsilon \qquad (1)$$

y_{ct} = health (life expectancy, infant mortality, under 5 mortality, physicians, immunization rates, hiv/aids Incidence)
x_1 = ethnic fractionalization
x_2 = education (school life expectancy)
x_3 = gni per capita
x_4 = us foreign aid
δ_c = country fixed effects
δ_t = time fixed effects
ε = error term

The aim of the OLS regression is to evaluate the model for correlation. I include both country fixed effects and time fixed effects in this regression. The time fixed effects aim to control for underlying observable and unobservable differences across time that do not vary between the countries. Country fixed effects control for country characteristics that are not varying across time.

In the panel HIV/AIDs is standardized by population. I standardize the HIV/AIDs incidence measure by country level population to account for the fact that population in these

countries varies a lot. For readability of results, ethnic fractionalization values are multiplied by 100 in the panel and U.S. foreign aid is divided by one million.

SECTION 6: RESULTS

The following tables present the results of estimating equation 1 for Life Expectancy,, Infant Mortality, Under 5 Mortality, Physicians, Immunization Rates, HIV/AIDS Incidence.

Table 4: Ethnic Fractionalization and Life Expectancy

	Estimate	Standard Error	t value	Pr(>|t|)
Ethnic Fractionalization	- 0.6075**	0.2148	-2.828	0.00528
GNI Per Capita	-0.1352 x 10^{-2}**	0.0004768	-2.836	0.00516
School Life Expectancy	0.03028	0.3453	0.088	0.93023
US Foreign Aid	0.1308 x 10^{-4}	0.0001405	0.093	0.92595
Intercept	99.58***	16.62	5.990	0.0000000134
Multiple R-squared: 0.9596				
Adjusted R-squared: 0.9493				
F-statistic: 92.76 on 41 and 160 DF				
p-value: < 2.2e-16				

*Significance Level codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.' , 0.1 ' ' 1*

Table 4 displays the results for life expectancy with time and country fixed effects. In this regression, the coefficient on ethnic fractionalization is negative (-0.6075) and statistically significant, meaning as ethnic fractionalization increases, life expectancy decreases. The coefficient on GNI per capita is also negative (-0.1352 x 10^{-2}) and statistically significant. Similarly as GNI Per Capita increases, life expectancy decreases. The coefficients for school life

expectancy (0.03028), and US foreign aid (0.1308 x 10^{-4}) are both positive but statistically

insignificant.

Table 5: Ethnic Fractionalization and Infant Mortality

	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	-0.03061***	0.6164	-4.965	0.00000174
Ethnic Fractionalization	5.283***	0.7965	6.633	0.000000000483
GNI Per Capita	0.6052 x 10^{-2}***	0.001768	3.423	0.000787
School Life Expectancy	1.296	1.28	1.012	0.313135
US Foreign Aid	-0.2789 x 10^{-3}	0.000521	-0.535	0.593251
Multiple R-squared: 0.9645				
Adjusted R-squared: 0.9555				
F-statistic: 106.2 on 41 and 160 DF				
p-value: < 2.2e-16				

*Significance Level codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.' , 0.1 ' ' 1*

Table 5 displays the results for infant mortality with time and country fixed effects. In

this regression, the coefficient on ethnic fractionalization is positive (5.283) and statistically

significant. This implies that increased ethnic fractionalization is associated with increased infant

mortality. The coefficient on GNI per capita is also positive (0.6052 x 10^{-2}) and statistically

significant. This means that as GNI per capita increases infant mortality increases. The

coefficient for school life expectancy is positive (1.296). The coefficient for for US foreign aid

is negative (-0.2789 x 10^{-3}). Both statistically insignificant.

Table 6: Ethnic Fractionalization and Under 5 Mortality

	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	-0.07294***	0.018	-4.052	0.0000791
Ethnic Fractionalization	0.1164***	2.326	5.005	0.00000146
GNI Per Capita	0.02158***	0.005164	4.179	0.00004
School Life Expectancy	0.1075**	3.739	2.875	0.004594
US Foreign Aid	-0.4501×10^{-3}	0.001522	-0.296	0.767791
Multiple R-squared: 0.9366				
Adjusted R-squared: 0.9203				
F-statistic: 57.62 on 41 and 160 DF				
p-value: < 2.2e-16				

*Significance Level codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.' , 0.1 ' ' 1*

Table 6 displays the results for under 5 mortality with time and country fixed effects. In this regression, the coefficient on ethnic fractionalization is positive (0.1164) and statistically significant. This implies that an increase in ethnic fractionalization is associated with an increase in under 5 mortality. The coefficient on GNI per capita is also positive (0.02158) and statistically significant. As GNI per capita increases under 5 mortality increases. The coefficient for school life expectancy is also positive (0.1075) and statistically significant. Which implies that an increase in school life expectancy is associated with an increase in under 5 mortality. While this result is statistically significant, it is not economically significant. The coefficient for US foreign aid is negative (-0.4501×10^{-3}) and statistically insignificant.

Table 7: Ethnic Fractionalization and Physicians

	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	0.03319	0.6895	0.048	0.961845
Ethnic Fractionalization	-0.4102×10^{-4}	0.008856	-0.005	0.996327
GNI Per Capita	-0.1956×10^{-4}	0.00002385	-0.820	0.416754
School Life Expectancy	0.02394	0.01818	1.317	0.195045
US Foreign Aid	-0.4086×10^{-5}	0.00001080	-0.378	0.707080
Multiple R-squared: 0.9693				
Adjusted R-squared: 0.9423				
F-statistic: 35.93 on 36 and 41 DF				
p-value: < 2.2e-16				

*Significance Level codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 ' ' 1*

Table 7 displays the results for the number of physicians with time and country fixed effects. In this regression, the coefficient on ethnic fractionalization is negative (-0.4102×10^{-4}). The coefficient on GNI per capita is also negative (-0.1956×10^{-4}). The coefficient for school life expectancy is positive (0.02394) and for US foreign aid is negative (-0.4086×10^{-5}). However, all of the coefficients in this model are statistically insignificant.

There were years where data were not collected in all countries for physicians. Note that the degrees of freedom for this model is 41 which is much smaller than other models that have over 150 degrees of freedom . The lack of data could be due to issues accessing rural areas or lack of consistent collection methods making data unreliable.

Table 8: Ethnic Fractionalization and DPT Immunization

	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	-214.7*	103.8	-2.067	0.040343
Ethnic Fractionalization	3.623**	1.341	2.701	0.007672
GNI Per Capita	-0.01007**	0.002991	-3.365	0.000960
School Life Expectancy	-2.431	2.154	-1.129	0.260788
US Foreign Aid	-0.5552 x 10^{-3}	0.0008761	-0.634	0.527129
Multiple R-squared: 0.8454				
Adjusted R-squared: 0.8053				
F-statistic: 21.07 on 41 and 158 DF				
p-value: < 2.2e-16				

*Significance Level codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.' , 0.1 ' ' 1*

Table 8 displays the results for DPT immunizations with time and country fixed effects. In this regression, the coefficient on ethnic fractionalization is positive (3.623) and statistically significant. An increase in ethnic fractionalization is associated with an increase in the immunization rate. The coefficient on GNI per capita is negative (-0.01007) and statistically significant. As GNI per capita increases, the immunization rate decreases. The coefficients for school life expectancy (-2.431), and US foreign aid (-0.5552 x 10^{-3}) are both negative but statistically insignificant.

Table 9: Ethnic Fractionalization and HIV/AIDS Incidence

	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	-0.00202	0.003623	-0.557	0.577991
Ethnic Fractionalization	0.3342×10^{-4}	0.00004682	0.714	0.476323
GNI Per Capita	-0.6312×10^{-7}	0.01039×10^{5}	-0.607	0.544491
School Life Expectancy	-0.1477×10^{-3}.	0.00007526	-1.962	0.051484
US Foreign Aid	-0.8805×10^{-8}	0.003063×10^{5}	-0.288	0.774099
Multiple R-squared: 0.8736				
Adjusted R-squared: 0.8412				
F-statistic: 26.98 on 41 and 160 DF				
p-value: < 2.2e-16				

Significance Level codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 ' ' 1

Table 9 displays the results for HIV/AIDS incidence with time and country fixed effects. In this regression, the coefficient on ethnic fractionalization is positive (0.3342×10^{-4}) and statistically insignificant. The coefficient on GNI per capita is negative (-0.6312×10^{-7}) and statistically insignificant. The coefficient for US foreign aid (-0.8805×10^{-8}) is negative and statistically insignificant. The coefficient for school life expectancy (-0.1477×10^{-3}) is negative and statistically significant. This implies that an increase in school life expectancy is associated with a decrease in HIV/AIDs incidence.

SECTION 7: DISCUSSION

Findings indicate that an increase in ethnic fractionalization is associated with increased infant and under 5 mortality and decreased life expectancy. These findings are consistent with previous literature finding negative impacts of ethnic fractionalization on a variety of outcomes. They are also consistent with more specific studies (Platas 2011; Churchill, Exornam Ocloo, Siawor-Robertson 2016) on the impacts of ethnic heterogeneity on health outcomes. These results further expand the literature by looking specifically at the region of West Africa.

I was surprised to find that an increase in GNI Per Capita is associated with decreased life expectancy, immunization rate and increased infant mortality and under 5 mortality. Generally increased income should lead to more opportunities to improve standard of living. The results may be due to how income is distributed amongst the population. It may be a situation where the poor stay poor and the rich get richer. Increased school life expectancy is associated with decreased HIV/AIDS incidence and increased under 5 mortality. Education is a social determinant of health according to the CDC therefore I anticipated school life expectancy to positively impact health outcomes as it did with HIV/AIDS incidence. In a future study it may be worth investigating if an increase of under five mortality is related to a decrease in infant mortality.

US Foreign Aid was insignificant in every model. It is beyond the scope of this paper to dig into this result. However, this could be due to the funds not being used for their intended purpose. It could also be due to how broad the foreign aid data are. Future studies could investigate specific foreign aid projects to evaluate how they impact health outcomes.

This study did not reveal much about how ethnic fractionalization impacts the number of physicians. I believe these limitations have not impacted the main findings of the study. Future work may explore different measures of health care accessibility and access.

SECTION 8: CONCLUSION

This study examines the relationship between ethnic fractionalization and health outcomes. Overall I find mixed effects of ethnic fractionalization, GNI Per Capita, School Life Expectancy, and US Foreign Aid on health outcomes. Results illustrate that higher levels of ethnic fractionalization are associated with increased infant and under 5 mortality and decreased life expectancy. GNI Per Capita decreases life expectancy, immunization rate and increases infant mortality, under 5 mortality. School life expectancy decreases HIV/AIDS incidence and increases under 5 mortality. There are no significant results for US Foreign Aid.

When assessing Africa's health outcomes it is critical to highlight how Africa's colonial past has influenced the continent today. The exploitation of Africa's resources and people broke down Africa's existing complex cultural system and stunted the continent's growth. Furthermore the artificial borders erected during Africa's colonial era left a lasting impression on the continent, particularly in regards to health infrastructure and outcomes.

Overall my findings highlight that ethnic fractionalization has negative impacts on health outcomes. The more ethnically fractionalized a country is, the worse health outcomes are for the people. This speaks to the lasting impacts of the partitioning of West Africa and colonization. The negative economic, social, and political impacts extend far into the health system. The 70 years of colonization was detrimental to the lives of West African people.

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