Africa's Health Tragedy?
Ethnic Diversity and Health Outcomes*

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Abstract

Scholars have found ethnic diversity to be a key explanatory variable for economic growth and local public goods provision, and for certain health outcomes, such as infant mortality. In this paper, I examine the effect of ethnic diversity on a broad range of health outcomes in a global sample of countries, as well as by region and income level, with particular emphasis on the sample of sub-Saharan African countries. I also conduct an analysis of the relationship between ethnic diversity and health care provision at the sub-national level within the East African country Uganda. I find that in the global model, with a wide range of controls, greater ethnic diversity is associated with poorer health outcomes, including higher infant and child mortality, and lower public health expenditure. However, I find that the determinants of health outcomes, and the relationship between ethnic diversity and health outcomes, varies by region and income level. Within Africa, I find that variation in health outcomes is explained primarily by access to health facilities, as well as the quality of institutions. Within Uganda, I find that more ethnically diverse districts tend to have lower provision of health services but the same amount of physical health infrastructure as their homogeneous counterparts.

Keywords: Ethnicity, Health, Mortality, Africa, Infrastructure, Corruption, Uganda, Immunization

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1 Introduction

While tremendous progress has been made in the field of public health over the past few decades, life for many people remains nasty, brutish and short. Over 7 million children under five years of age will die in this year alone, equivalent to 19,000 deaths per day or 13 deaths every minute (Rajaratnam et al 2010). Although worldwide maternal mortality rates today are lower than ever, over 300,000 women die every year while giving birth (Hogan et al 2010). The direct causes of death in children and mothers, which include infectious diseases such as pneumonia, diarrhea, and malaria in children, and hemorrhaging in pregnant women, are well known (Black et al 2010, Khan et al 2006). In most cases, inexpensive methods of prevention and treatment of these direct causes are known as well (Kinney et al 2010, Black et al 2010). However, while the proximate causes of this massive loss of life are well established, the ultimate causes of these needless deaths are less well understood. Poverty explains much of the cross-country variation in mortality rates and other health outcomes, but some poor countries have been relatively more successful than others in improving the health of their citizens, and some rich countries have been relatively less successful. Why are some countries more successful than others in using scarce resources to improve the lives of their citizens?

Much of the work in political science regarding the determinants of health outcomes has focused on regime type as an explanatory variable (Przeworski et al 2000, McGuire 2005, Besley and Kudamatsu 2006). Yet, to date, the literature on regime type and health outcomes cross-nationally is inconclusive. While a number of scholars have found a negative relationship between democracy and infant mortality (Przeworksi et al 2000, Lake and Baum 2001, Zweiful and Navia 2000, Besley and Kudamatsu 2006), a recent study by Ross (2006) finds little or no effect of democracy on infant and child mortality once missing-data are accounted for in cross-national panel data. Given the tenuous relationship between democracy and health outcomes, and given the wide variation in health outcomes within regime types, there is need to look beyond regime type as a determinant of the quality of public health.

This paper examines ethnic diversity as a key explanatory variable in determining a range of health outcomes. In particular, I examine the relationship between ethnic diversity and a number of health outcomes, including mortality rates, life expectancy, immunization rates, disability adjusted life years (DALYs), and total fertility rates (TFR), globally, regionally, and by income group classification. I examine potential intermediating variables linking ethnic diversity and development outcomes, including quality of institutions and policy. As proposed by Alesina et al (2003), I include control variables that serve as proxies for quality of policies and institutions, including female educational attainment, control of corruption, and road density. I find that while ethnic diversity appears to have a negative effect on health outcomes globally, the relationship between ethnic diversity and health varies by region and does not explain cross-national variation in health outcomes within Africa. The key determinants of health in Africa, a region with a disproportionately large share of the global burden of death and disease, are different from key determinants of health globally. However, in sub-national analyses of one country, Uganda, I find that ethnically diverse districts perform poorly in certain areas of health care provision relative to their ethnically homogeneous counterparts.

Although I cover a global sample of countries, I devote particular attention to explaining variation in health outcomes in sub-Saharan Africa.[1] African countries and citizens experience some of the worst health outcomes in the world, and African countries account for a growing proportion of worldwide child and maternal mortality (Hogan et al 2010) as well as a growing number of child deaths in absolute terms (United Nations 2010). Mean life expectancy in Africa is nearly 15 years less than mean life expectancy in any other region, under-five mortality greater by 67 deaths per thousand, maternal mortality greater by 375 deaths per hundred thousand, and fertility greater by more than two children per woman. While home to only 10 percent of the worlds population, 50 percent of child deaths occur in Africa. This translates into 4.4 million child deaths in Africa in the year 2008 alone, equivalent to more than twice the death toll of the 20-year Vietnam War, the deadliest war[2] since World War II (Kinney et al 2010, Lacina and Gleditsch 2005). Most of these deaths are preventable, and result from diseases whose treatment is known and inexpensive (Black et al 2010, Kinney et al 2010). Understanding the effect of ethnic diversity on health outcomes in Africa, if there are any, is thus important both theoretically and normatively.

The interest in understanding the determinants of health outcomes in Africa is not merely academic. African governments have themselves begun to devote considerable time and resources to addressing the health outcomes of mothers and children on the continent. During the July 2010 African Union Summit, whose theme was Maternal, Infant and Child Health and Development in Africa, heads of state and government from 35 African countries spent two days discussing maternal and child health, and the challenges to addressing health care delivery in their respective countries. Understanding the determinants of health outcomes in Africa is thus important not only from a theoretical perspective, but also from a policy perspective.

This work contributes to several fields in the social science literature. First, although prior research in public health and development economics has used ethnic diversity as a control variable in explaining a number of health outcomes (Filmer and Pritchett 1999, Lewis 2006), to my knowledge, this is the first analysis that examines the effect of ethnic diversity as the primary explanatory variable across a broad

[1] Henceforth I will refer to sub-Saharan Africa as Africa, and North Africa will be grouped in the region North Africa and the Middle East (NAME), a common empirical decision in the literature.

[2] Estimated at 2,097,705 battle deaths.

range of health outcomes across and within geographic regions and income levels. As such, the analysis pays closer attention to the conditions under which ethnic diversity affects health outcomes, and thus illuminates complexities of the relationship which might otherwise be overlooked. Second, I add to the burgeoning literature on ethnic diversity and public goods provision, a literature which does use ethnic diversity as the key explanatory variable. While much of this work examines the role of ethnic diversity in explaining poor public goods provision in African countries (Miguel 2002, Miguel and Gugerty 2005, Habyarimana et al 2009), the analysis here suggests that while ethnic diversity may be the cause of poor public goods provision at the local, or community level, ethnic diversity does not explain much, if any, of the cross-national variation in health outcomes in the worlds most ethnically diverse region, Africa.

The rest of the paper proceeds as follows: Section 2 reviews the literature on ethnic diversity as an explanatory variable, and discusses the theorized mechanisms underlying the relationship between ethnic diversity and public goods provision, including health. Section 3 discusses the data and methods. Section 4 presents the results of the empirical analysis for the global sample of countries. Section 5 presents the results of the empirical analysis for the African sample of countries. Section 6 presents the sub-national analysis of Uganda. Section 7 provides a brief discussion, and Section 8 concludes.

2 Ethnic Diversity, Public Goods and Health

In the past two decades, ethnic diversity has been widely used in the disciplines of economics and political science to explain a number of outcomes relating to governance and economic growth. Before examining the effect of ethnic diversity on health outcomes, it is important to clarify what it is we mean by ethnic diversity, as well as to acknowledge the challenges and limitations in using this explanatory variable.

2.1 Ethnic Diversity and its Discontents

The most commonly used measure of ethnic diversity is ethnolinguistic fractionalization (ELF), a Herfindahl index constructed from data collected by Soviet ethnographers, and published in Atlas Naradov Mira (Atlas of the Peoples of the World) in 1964. This measure is based primarily, though not exclusively, on national linguistic diversity. While some scholars have taken ethnic diversity, and ELF in particular, as exogenous to political and economic conditions (Canning and Fay 1993, Mauro 1995), many others have argued and demonstrated that ethnicity is not fixed but is instead a malleable social construct, and that multiple ethnic identities and cleavages can exist simultaneously and/or over time (Laitin and Posner 2001, Fearon 2003, Posner 2004). Out of the debate on both the validity and reliability of ELF emerged a number of alternative indices of ethnic diversity as well as updates to the original Atlas data (Roeder 2001, Fearon 2003, Alesina et al 2003, Posner 2004).

While these new measures, constructed by some of the top scholars in the areas of ethnicity and identity politics, have attempted to take into account constructivist critiques of ELF, they are also in greater danger of being endogenous to the phenomena social scientists are trying to explain. In comparing the coding of ethnic diversity in Botswana and Somalia, two countries whose ethnic homogeneity are arguably similar, Fearon (2003) notes the danger in constructing indices of ethnic fractionalization after knowing the dependent variable to be explained:

> If for some reason Botswana's economy had done poorly over the last 30 years, and if it had seen significant internal fighting along tribal lines, it would have been viewed ex post as confirmation of the regularity that ethnic diversity makes for lower growth and a greater risk of civil conflict! ... If Botswana seems more ethnically homogeneous than Somalia does at this point, it may be that this is in part a result rather than a cause of economic growth ... This may be an argument for using a list of ethnic groups constructed in 1960, such as the Atlas Naradov Mira, to study subsequent economic growth or political conflict. (Fearon 2003: 198-9)

Scholars using ethnic diversity as an explanatory variable thus face a number of threats to inference, regardless of their dependent variable of interest. First, due to numerous data collection challenges (discussed by Fearon 2003 and Laitin and Posner 2001), there is likely to be measurement error in cross-national and time-series indices of ethnic diversity. Second, measures of ethnic diversity, especially those constructed recently, may be endogenous to the phenomena they are employed to explain. Third, one or more omitted variables may ultimately lie behind the statistical relationship between ethnic diversity and various political, economic and development outcomes social scientists have discovered and continue to reveal. These challenges do not mean ethnic diversity as an explanatory variable should be abandoned altogether, but rather that we should be aware that the burden of proof of a real causal relationship lies very heavily on the researcher.

With these challenges in mind, for the analysis presented in this paper I have chosen the Atlas Naradov Mira ELF index, as reproduced in Fearon and Laitin (2003), as my primary measure of ethnic diversity. I cross-check my results with alternative indices, to be discussed in the data and methods section of the paper. Despite the inherent measurement error problems in using ELF that I have discussed above, I use it as my primary measure because it is the measure least likely to be endogenous to the dependent variables examined here, health indicators.

The greatest concern remaining, therefore, is the possibility of omitted variable bias. Past research has identified a number of variables correlated to ethnic diversity, which may also have an effect on the dependent variable of interest. Two of these include economic growth (Easterly and Levine 1997) and tropical disease environment. Ethnic diversity is highly correlated with certain climatic zones, namely tropical ones, and thus, there is greater ethnic diversity where there is also greater tropical disease, such as malaria. Nettle (1998) provides evidence supporting the claim that ecological environment has been a key determinant of linguistic diversity in the course of human history.[3] In tropical environments with little climatic variability small groups of people had the capacity to be self-sufficient, and linguistic diversity was great. In environments with greater climatic variability, larger social networks were required for survival, resulting in less linguistic diversity (Nettle, 354). Thus, linguistic diversity is correlated with climate, which is in turn correlated with disease environment. In the empirical analysis, I control for malaria prevalence, which I use as a proxy for disease environment. GDP per capita is also controlled for in all of the empirical analyses.

2.2 Ethnic Diversity and Public Goods

Although there are many challenges in using ethnic diversity, and ELF in particular, as an explanatory variable, scholars have used laboratory experiments (Habyarimana et al 2007, 2009) and innovative instrumental variable approaches, including the use of historically determined ethnic settlement patterns (Miguel and Gugerty 2005), among other identification strategies, to demonstrate that there is strong evidence of a causal relationship between ethnic diversity and substantively important outcomes.

Habyarimana et al (2007) classify the mechanisms underlying the relationship between ethnic diversity and public goods into three families: preferences, technology, and strategy selection. Through their laboratory experiments in an ethnically heterogeneous suburb of Kampala, Uganda, they find evidence supporting the latter two mechanisms. In a series of experimental games, they find that co-ethnics play cooperative equilibria, but when given the same experimental set-up, non-co-ethnics do not, suggesting a strategy selection mechanism is at work. They also find that co-ethnics are better linked to and able to rely on social networks, a technology which may facilitate cooperating and forestall problems of collective action in homogeneous environment. Miguel and Gugerty (2005) also find evidence in support of a social sanctioning mechanism, a form of strategy selection, in determining the level of primary school funding and quality of school facilities in Kenya.

Though much of the work on ethnic diversity and public goods provision examines communities in developing countries, there is evidence to suggest that a similar relationship exists in developed countries as well. In their study of select U.S. geographic areas, Alesina, Baqir and Easterly (1999) emphasize the role

[3] Nettle suggests, however, that Eurasian expansion is currently in the process of altering the causal relationship at work through the introduction of technology, language, people, crops and diseases (Nettle 1998, 369).

of heterogeneous preferences over policy and distribution of public goods in the determination of share of spending on public goods. Vigdor (2004) finds that more diverse communities in the U.S. were less likely to complete and return the 2000 Census questionnaire, even when doing so would have resulted in public benefits via federal funding.

There are at least two deficiencies in our understanding of the mechanisms proposed thus far linking ethnic diversity to public goods provision. First, it is not clear when each is applicable or not to a given community. The reason why ethnic diversity is detrimental to funding of public schools in a major U.S. city, for example, may be quite different from the reason ethnic diversity is detrimental to *harambee* (village fundraiser) collections for local schools in rural western Kenya. Thus far, we do not have a good understanding of the circumstances under which particular mechanisms will be more or less applicable to a given community.

Second, the proposed mechanisms explaining how ethnic diversity leads to poor public goods provision within particular communities does not necessarily explain why the relationship exists between ethnic diversity and poor economic, political and development outcomes at the national level. For example, the mechanisms enabling a homogenous community to work collectively may not be the same as those that enable a homogenous country to enact national policies that encourage economic growth, or effective and efficient provision of public goods.

It is possible that some of the effect of ethnic diversity on health outcomes at the national level is due to the aggregate effect of ethnic diversity on local public goods provision within a country. However, there are many countries that are heterogeneous at the national level, while remaining largely homogenous at the local level. For example, in many highly ethnically heterogeneous African countries, the boundaries of ethnic groups often coincide with administrative boundaries. Thus, while a highly diverse country like Uganda may have over 60 constitutionally recognized ethnic groups, the spatial organization of ethnicity means that most individuals live amongst co-ethnics in more or less homogenous communities.

To test whether poor outcomes at the national level are a result of aggregated poor outcomes caused by ethnic diversity at the local level, we would need not only the commonly used cross-national ELF index, but also sub-national ELF indices by community, district, or some other administrative boundary, and measures of public goods for each of these sub-national units. To my knowledge there is no comprehensive dataset of sub-national ELF indices by country, although scholars have begun to construct such datasets on a country-by-country basis (Miguel 2002, Glennerster, Miguel and Rothenberg 2010). In this paper, I present preliminary analysis of the relationship between public goods provision and sub-national ethnic diversity in Uganda, using data from the 2002 Uganda Census and the Uganda Bureau of Statistics. This is only a rough cut at the sub-national data from one country, but it may be replicated in other countries conditional on the availability of census or other survey data on ethnicity.

In addition to local collective action problems in heterogeneous communities, scholars have also looked to theories of competitive rent-seeking to explain why heterogeneous countries perform poorly politically and economically. Easterly and Levine (1997) argue that ethnic diversity leads to uncoordinated rent-seeking, common pool problems where each group grabs as large a share of rents as possible, and polarization of preferences over the type of public goods to be provided. Bad public policies and political instability are the consequences of competitive rent-seeking, they argue, and are the intermediating variables underlying the relationship between ethnic diversity and economic growth. Alesina et al (2003) also show that the negative effect of ethnic diversity on economic growth vanishes as intermediating variables, such as schooling, fiscal surplus and the log of telephones per worker are controlled for. They further find that corruption, infant mortality rates and illiteracy are all correlated with ethnic diversity after controlling for GDP per capita - all evidence, they argue, that ethnic diversity leads to poor quality of government and poor policies.

A related explanation is that of inequality. If ethnic diversity, via uncoordinated rent-seeking or favoritism, leads to inequality in the provision of public goods, lower provision for certain (or most) groups may significantly lower the average provision of public goods at the national level. To test this mechanism, one would need to create a measure of inequality of public goods provision within a country. While measures of income inequality, however problematic, exist, I have yet to find a cross-national measure of inequality of public goods provision.

According to the theories advanced so far, ethnic diversity appears to be at work on at least two levels. In heterogeneous countries, ethnic diversity leads to uncoordinated rent-seeking at the level of the national government, which in turn leads to bad public and economic policies, and inequality in public goods provision. In heterogeneous communities, ethnic diversity inhibits public goods provision by impeding social sanctioning, making cooperation more technologically difficult, and causing disagreement over which public goods should be provided. There may also be different combinations of mechanisms at work depending on how ethnic populations are spatially organized. There may be heterogeneous countries with heterogeneous communities, or heterogeneous countries with homogenous communities.

In this paper, I attempt to test two of the proposed theories. First, I test the theory of intermediating variables, namely quality of policies and institutions, as explaining the relationship between ethnic diversity and health outcomes. My approach is similar to that of Easterly and Levine (1997) and Alesina et al (2003), which is to use proxy variables for the quality of policy and institutions as intermediating variables.

Here, however, the dependent variables of interest are specifically health outcomes, instead of the primarily economic outcomes examined by the aforementioned authors. Second, I conduct a first and rough cut testing the theory that poor public goods provision outcomes at the national level are the result of aggregated poor outcomes at the local level. In particular, I calculate ELF at the district level for one country, Uganda, and compare public goods provision across homogenous and heterogenous districts. In the future I would like to expand this analysis by including more countries, and gathering more data on control variables at the district level.

2.3 Ethnic Diversity and Health

The literature to date on the effects of ethnic diversity on a variety of outcomes suggests that ethnic diversity may be a key explanatory variable in determining variation in health outcomes. Alesina et al (2003) find ethnic diversity to have a significant effect on infant mortality even after controlling for GDP per capita and latitude. Ghobarah, Huth and Russett (2004) also find ethnic diversity to be associated with lower public health spending as a percentage of GDP, and to have a weak negative effect on health-adjusted life expectancy (HALE).[4] In his study of government responses to HIV/AIDS, Lieberman (2007) finds that ethnic diversity is associated with lower per capita government AIDS expenditures, lower anti-retroviral treatment coverage, lower AIDS policy scores, and fewer mentions of HIV/AIDS in annual budget speeches. Lieberman proposes an alternative mechanism linking ethnic diversity to health out- comes, different from those discussed in the public goods literature. He argues that ethnic diversity alters perceptions of risk. In particular, When societies are ethnically divided and fragmented, elites are less likely to mobilize around the idea of risk from a stigmatized condition, fearing that their group will suffer reputational consequences. (Lieberman 2007, 1407)

A number of scholars have also used ELF as a control while testing the effect of other independent variables, such as regime type (Besley and Kudamatsu 2006), public health spending (Filmer and Pritchett 1999) and corruption (Lewis 2006, Kricheli 2010) on public health outcomes such as child and infant mortality, hospital beds per capita, life expectancy, and access to improved sanitation facilities.

In this paper I first establish the relationship between ELF and a variety of health outcomes, controlling for GDP per capita, regime type, and malaria prevalence. I then examine the effect of potential intermediating variables, which are the quality of a country's policies and institutions, through which ethnic diversity may have only an indirect effect on health outcomes. These intermediating variables include control of corruption,

[4] HALE is an health indicator constructed by data from the World Health Organization (WHO) that discounts life expectancy by the average number of years an individual in a given country can expect to live with disability caused by disease or injury.

female education, and road density. These variables are not only indicative of the quality of a countrys policies and institutions in general, but also are likely to have an effect on health outcomes in particular. Finally I examine the effect of ELF on public goods provision at the district level in Uganda, a highly ethnically diverse country.

Corruption is thought to have both direct and indirect effects on public goods provision (Mauro 1995, Alesina et al 2003), both positive and negative (Kricheli 2010). Corruption may lead to poor economic growth, which results in lower tax collection and spending on public goods, or may lead to inefficiency of provision as money allocated to public goods is siphoned off for private use (Reinikka and Svensson 2004). On the other hand, Kricheli (2010) argues that the effect of corruption on public goods provision is conditional on regime type. Specifically, while corruption is detrimental to public goods provision in democracies, Kricheli finds that corruption is associated with better public goods provision among autocratic states.[5]

Other potential intermediating variables found to affect health outcomes include education (Hill and King 1993) and infrastructure (Leipziger et al 2003). Increased female education has been found to improve health outcomes, including reduction in infant and maternal mortality, through better knowledge of health practices and reduction in fertility (Hill and King 1993). Infrastructure could include a broad range of variables, but in this analysis I focus specifically on road density. Road density is a measure of state capacity that indicates the extent to which state power and control can be exerted across a territory (Herbst 2000). While road density does not appear to be widely used as a control or independent variable for health outcomes, at least one recent study used a control for road density while examining the effect of governance scores on health outcomes (Lewis 2006). Roads may be important for health outcomes because, as Herbst (2000) notes, they are literally a two-way street - roads allow citizens access to health facilities, and allow the state access to its population. In the empirical analysis, I examine the effect of ethnic diversity on health outcomes while controlling for these potential intermediating variables, a strategy employed by Alesina et al (2003).[6] In the next section I discuss the data and methods employed.

[5] In models not presented in this paper, I interacted the corruption and polity variables, a technique Kricheli uses with a dichotomous regime type variable, but this interaction did not yield any significant results.

[6] See, for example, Table 6 in Alesina et al 2003.

3 Data and Methods

3.1 Sample

The sample for the global model includes 159 countries in existence by 2000 with a population of greater than 500,000.[7] The unit of analysis is the country. Since ELF is time invariant, it is not possible to conduct time series analyses using ELF as an independent variable. If ELF were entered in time-series regression, any relationship between ELF and the dependent variables would be artificially amplified and the standard errors of the coefficients would be misleading. For this reason, I have gathered data on the dependent variables of interest for the most recent year they are available. Where possible, I have used averages over a number of years for the control variables, such as polity scores, a technique which has been used by others using ELF as an independent variable (Lieberman 2007).[8]

In addition to the full world sample, I also conduct income level and regional analyses in order to determine whether the relationships between the independent and dependent variables of interest vary by region or income level. I use the regional categories as delineated in Fearon and Laitin (2003). There are six regions: West, Sub-Saharan Africa, Latin America, Eastern Europe, Asia, and North Africa and the Middle East (NAME). I use the four income level categories as defined by the World Bank for the year 2007: low income (GNI $0-$995), lower-middle income ($996-$3,945), upper-middle income ($3,946-$12,195), and upper income ($12,196 and above).

The sample for the sub-national data on Uganda includes 76 districts in existence in 2007. The number of districts in Uganda has grown over time. 21 of these districts have been created since 2002 (the year of Uganda's most recent census), and 17 parent districts have lost territory to these new districts. The most recent data I have collected at the district level aggregates the data according to the districts as of 2007. Thus, my analyses employ ELF at the 2007 district level.[9]

3.2 Health Outcomes

I use a number of health indicators as dependent variables in the cross-national analyses. I have used the logged value for variables that are highly skewed. These include: logged infant mortality rate in 2008 (*IMR*), logged under- five mortality rate in 2010 (*Under-5*), logged maternal mortality rate in 2010 (*MMR*), total fertility rate in 2008 (*TFR*), total life expectancy in 2008 (*Life*), average public health expenditure

[7]Belize and Serbia are excluded because there were not already existing ELF scores for these countries.

[8]In models not presented here, I used single year measures of control variables, which yielded similar results to models in which the average value was used.

[9]Data was not available for the districts Abim, Kaabong, and Nyadri and these districts have been omitted from the analysis.

as a percentage of GDP between 2003 and 2007 (*Expend*), logged per capita health spending (*Healthpc*), yearly change in maternal mortality rate between 1990 and 2008(changeMMR), immunization rates in 2008 (Immune), logged disability adjusted life years (*DALY*) in 2004, percentage of mothers who deliver with the aid of a trained birth attendant for years 2005 to 2008 (*Birth*), and percentage of the population with access to improved sanitation facilities in 2006 (*Sanfac*). I have used the most recent values available for the dependent variables. This is because some data is missing for certain countries in earlier years, or data for certain health outcomes is not regularly collected (such as DALYs).[10]

In the sub-national analyses within Uganda, I examine several outcomes related to health care provision. These include: vaccination coverage for four vaccines (*Measles, OPT3, DPT3, and BCG*)[11], as well as the average coverage for all vaccines (*immuneavg*), pit latrine coverage (*Latrine*), the number of health centers (*Health Center*), and number of hospitals (*Hospital*).

Cross-national data are collected from the World Bank's World Development Indicators (WDI), the Institute for Health Metrics and Evaluation (IHME), and the World Health Organization (WHO). I use the most recent country-year data point available for each indicator. WDI and WHO data is available for almost all countries, while some IHME data is only available for certain developing countries.

District level data for Uganda are collected from the Uganda Bureau of Statistics and 2002 national census. Detailed coding and definitional information for the dependent variables can be found in the Appendix (A.1).

3.3 Ethnic Diversity

I use ELF as reported in Fearon and Laitin (2003). Fearon and Laitin do not include Comoros, Qatar, or Equatorial Guinea. I use Roeder's (2001) ELF61 variable for these three countries. I cross-check my results using Fearon's (2003) measure of ethnic fractionalization and (*ELF2*), for the African region, Posner's (2004) measure of politically relevant ethnic groups (*PREG*).[12]

3.4 Control and Intermediating Variables

As noted previously, ELF is correlated with several variables that are likely to affect the health variables of interest. In the cross-national analyses I have attempted to include controls for these variables as well as other variables that are thought to effect health and health care provision. These controls include the log of

[10] Using the average value of child mortality and infant mortality, two of the variables for which there are multiple country-year observations, as the dependent variable did not significantly alter the results.

[11] OPT3 is three doses of the oral polio vaccine, DPT3 is three doses of the Diptheria, Pertusis Tetnus, Hepatitis B and Heamophilus influenzae vaccine, and BCG is the tuberculosis vaccine.

[12] Replication of results using *ELF2* are not presented here but are available upon request.

GDP per capita (*GDPpc*) in 2007, income inequality (*gini*), log of per capita official development assistance (*ODApc*) in 2008, rural population as a percentage of the total population in 2008 (*Rural*), years of civil war between 1990 and 2006 as coded by Doyle and Sambanis (*War Years*), percentage of the population living in areas of high malaria risk in 1994 (*Malaria*), female primary school completion rate as a percentage of relevant age group (*Education*), regime type as measured by the average Polity2 score from 2000 to 2008, rescaled to range from 0 to 20 (*Avg. Polity*), kilometers of road per square kilometer of land area (*Roads*), and control of corruption as measured by the average score between 1996 and 2008 from the World Governance Indicators (*Corruption*).[13]

Data on GDP per capita come from the Penn World Tables. Data for income inequality, ODA, population, and female education, and road density come from WDI. Malaria data is found in Gallup and Sachs (2001). Civil war data comes from Doyle and Sambanis unpublished dataset. Rescaled polity scores are the Polity2 variable of the 2008 Polity IV Project (Marshall, Jaggers and Gurr 2010). Control of corruption scores are from from the World Banks World Governance Indicators (Kaufmann, Kraay and Mastruzzi 2009).

In the sub-national analyses of Uganda I have included controls for logged district population (*Population*) and region (*Region*), but have not yet collected data on other important control variables, such as poverty rates. Nevertheless, region is a rough proxy for poverty rates as the poorest districts tend to be located in the north and east of the country.

3.5 Summary Statistics

There is great variation in worldwide child and maternal mortality rates. Figure 1 below demonstrates the variation in mortality across regions: The variation in maternal mortality is particularly striking, with the mean maternal mortality in Africa many times larger than else- where in the world. Infant mortality and under-five mortality are also much higher in Africa than elsewhere. Mortality rates in Asia are not as high as those in Africa, but are higher than those in the rest of the world.

There is significant variation, both globally and regionally, in other health outcome variables as well. Average number of disability- adjusted life-years in Africa is nearly 50,000 per 100,000, almost double the average number of DALYs in Asia, the region with the second highest mean. Average life expectancy in Africa is 14 years less than the worldwide average, total fertility in Africa (4.83 per woman) greater by nearly two births per woman than the world average, and average immunization rates, access to improved sanitary facilities and birth attendance all lower than the average in any other region. Africa has the second lowest

[13] In models not presented here I also included controls for population density and log area in kilometers squared but neither were significant and have been omitted in the cross-national analyses.

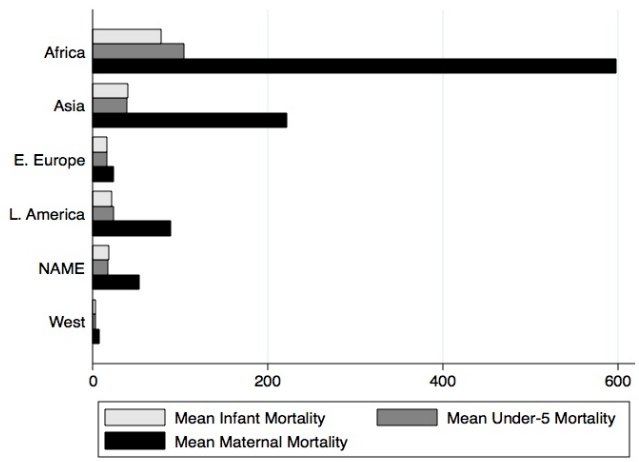

Figure 1: Mean Mortality Rates by Region

public health spending at 2.6% of GDP, behind Asia at 1.9%. Africa has lower average health spending per capita, at $81 per person, than any other region, and the median per capita health spending in Africa is even lower, at $33.50.

Average ethnic diversity also varies greatly by region. Figure 2 shows the mean ELF scores by region using the Atlas data and Fearon (2003), as well as mean malaria prevalence by region, demonstrating the high correlation between these variables in certain regions. Mean ELF and mean malaria prevalence are quite similar in Asia, Latin America, NAME and Africa, and non-existent in Eastern Europe and the West.

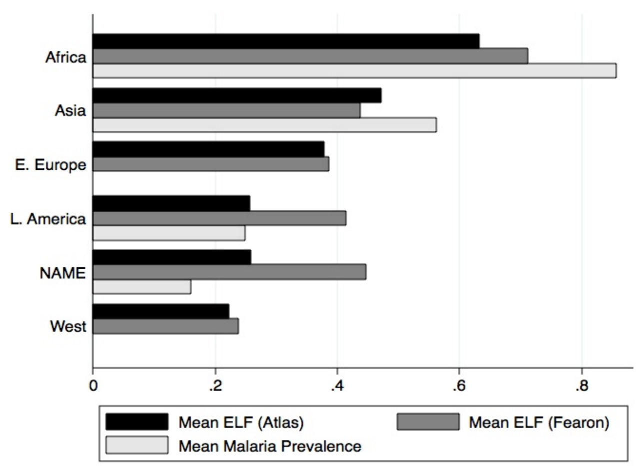

Figure 2: Mean ELF and Malaria Prevalence by Region

The key control variables of interest are control of corruption, road density, and female primary school completion rate. In a comparison of mean values of these variables by region, Africa performs most poorly. Mean road density in Africa is only 15.9 kilometer per square kilometer of land, nearly one third the average road density in Latin America, the region with the next lowest value at 43.4 kilometers. The average rate of female completion of primary school in Africa is only 60%, whereas the rate in every other region is above 80%. Africa also has the lowest average score of control of corruption. The control of corruption variable ranges from a minimum of -1.72 (Somalia) to a maximum of 2.39 (Finland). The mean control of corruption in Africa is -0.69.[14]

3.6 Bivariate Correlations

There are fairly strong correlations between ethnic diversity and a number of variables that may have an independent effect on health outcomes. These include GDP per capita and malaria prevalence. The correlation between these two variables and health outcomes are very strong. GDP per capita and infant mortality have a correlation of -0.58, and the correlation with other mortality rates is similar. The correlation between malaria prevalence (Gallup and Sachs 2001) and infant mortality is even higher, 0.77. It is thus important to control for both GDP per capita and malaria prevalence in the regression analysis. The correlation between GDP per capita and ELF in the full sample of countries is -0.34 and the correlation between malaria prevalence and ELF in 1994 is 0.51. Correlations of these variables with ELF2 (Fearon 2003) instead of ELF are nearly identical and slightly stronger. Figure 3 shows the bivariate relationship between the residuals of infant mortality after controlling for GDP per capita, regressed on the residuals of ELF after controlling for GDP per capita. Figure 4 shows the same relationship by region. Clearly, there appears to be a strong positive correlation across and within countries and regions even after taking into account country wealth.

[14]Additional figures of summary statistics can be found in Appendix A.2.

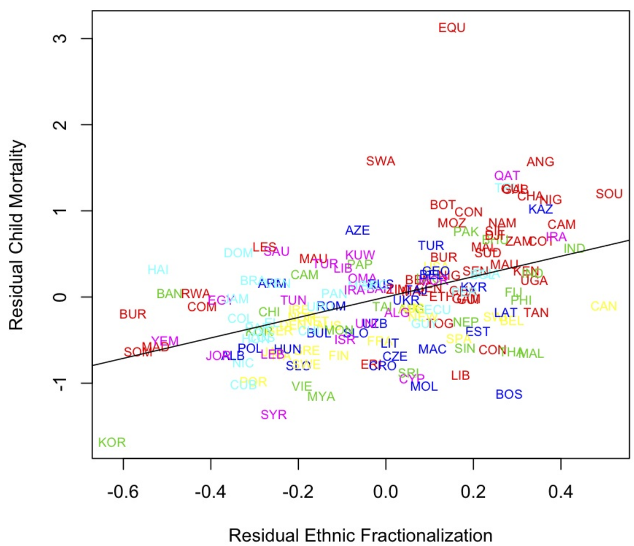

Figure 3: Residual Child Mortality on Residual ELF after Controlling for GDPpc

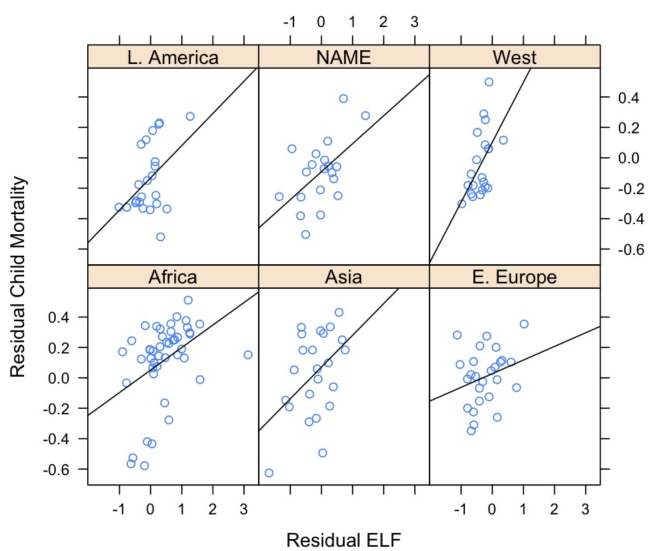

Figure 4: Child Mortality and ELF by Region

3.7 Model

In the cross-national analyses, I use ordinary least squares (OLS) regression in a cross-section of countries to examine the relationship between ethnic diversity and health outcomes. The basic model, taking into account poverty and regime type as alternative explanatory variables for health outcomes, as well as malaria prevalence and regional effects, is as follows:

$$y = \beta_1 + \beta_2(ELF) + \beta_3(GDPpc) + \beta_4(Avg.Polity) + \beta_5(Malaria) + \beta_6(Region) + \epsilon$$

The full model, with all controls, is as follows:

$$y = \beta_1 + \beta_2(ELF) + \beta_3(GDPpc) + \beta_4(Avg.Polity) + \beta_5(Malaria) + \beta_6(Education)$$

$$+\beta_7(Corruption) + \beta_8(Roads) + \beta_9(Gini) + \beta_{10}(ODApc) + \beta_{11}(Rural) + \beta_{12}(WarYears) + \beta_{13}(Region) + \epsilon$$

Where y is a health outcome variable.

In the sub-national analyses of Uganda's districts, I employ a similar OLS model, but the vector of control variables includes only district ELF, log population, and a region dummy.

4 Results: Ethnic Diversity and Health Outcomes in the World

I begin by testing the relationship between ELF and a number of health outcomes in the full sample of countries using the basic linear regression model. The results are presented in Table 1, where Asia is the baseline region. [15] [16]

[15] Robust standard errors are calculated using HC3 estimates of the heteroscedasticity consistent covariance matrix (HCCM), as discussed in Long and Ervin 2000.

[16] Results for the analysis of the world using ELF2 (Fearon 2003) were similar to those shown here.

Table 1: Ethnic Diversity and Health Outcomes in the World, Basic Model

	IMR	Under-5	MMR	TFR	Life	Expend.	Healthpc	Change	Immune	DALY	Birth	Sanit.
(Intercept)	6.45***	6.79***	8.44***	5.37***	45.04***	0.92	−4.76***	−0.03	90.70***	11.42***	−31.58	−11.59
	(0.66)	(0.73)	(0.93)	(1.12)	(6.97)	(1.19)	(0.82)	(0.03)	(17.28)	(0.43)	(31.02)	(21.99)
ELF	0.78***	0.71***	0.70**	0.67*	−3.77*	−1.40**	−0.27	0.01	−5.83	0.22*	0.87	3.18
	(0.18)	(0.19)	(0.25)	(0.26)	(1.77)	(0.45)	(0.19)	(0.01)	(4.80)	(0.09)	(8.54)	(6.57)
GDPpc	−0.40***	−0.44***	−0.47***	−0.41***	2.74***	0.12	1.04***	0.00	0.37	−0.18***	12.42***	9.20***
	(0.07)	(0.08)	(0.09)	(0.11)	(0.71)	(0.12)	(0.07)	(0.00)	(1.99)	(0.04)	(3.01)	(2.07)
Avg. Polity	−0.03**	−0.03**	−0.02†	−0.02†	0.17†	0.07**	0.04***	0.00	0.11	−0.01	0.11	−0.04
	(0.01)	(0.01)	(0.01)	(0.01)	(0.09)	(0.02)	(0.01)	(0.00)	(0.21)	(0.00)	(0.30)	(0.27)
Malaria	0.23	0.27	0.36	1.06***	0.37	−0.25	−0.08	−0.02	−10.69†	0.12	−15.63†	−13.51*
	(0.19)	(0.22)	(0.31)	(0.27)	(2.32)	(0.41)	(0.19)	(0.01)	(5.46)	(0.12)	(9.07)	(6.34)
E. Europe	−0.12	−0.00	−1.00***	0.24	0.53	1.23**	0.51*	−0.00	1.21	0.08	13.80	18.32**
	(0.21)	(0.22)	(0.28)	(0.23)	(1.83)	(0.41)	(0.21)	(0.01)	(3.77)	(0.09)	(9.09)	(6.28)
L. America	0.38†	0.35	−0.00	0.70**	1.32	0.93†	0.54**	−0.00	−5.01	−0.02	9.09	10.38
	(0.20)	(0.21)	(0.26)	(0.24)	(1.64)	(0.48)	(0.19)	(0.01)	(4.55)	(0.08)	(9.15)	(6.67)
NAME	0.02	−0.07	−0.49†	0.98***	2.58	0.70†	0.69**	−0.03**	−0.62	−0.14	13.51	13.47*
	(0.22)	(0.24)	(0.29)	(0.29)	(1.82)	(0.38)	(0.21)	(0.01)	(4.30)	(0.12)	(8.99)	(6.21)
Africa	0.55***	0.78***	0.91***	1.47***	−12.30***	1.19***	0.44*	0.03**	−6.21	0.52***	6.54	−14.70*
	(0.16)	(0.19)	(0.24)	(0.27)	(1.95)	(0.32)	(0.20)	(0.01)	(4.70)	(0.09)	(6.90)	(6.01)
West	−0.51*	−0.41	−1.28***	0.89***	4.53*	3.73***	1.63***	0.01	−1.51	−0.12	−0.38	15.76*
	(0.23)	(0.25)	(0.30)	(0.22)	(2.00)	(0.40)	(0.21)	(0.01)	(4.44)	(0.10)	(9.58)	(6.70)
N	152	152	152	152	152	152	150	152	150	151	105	130
R^2	0.86	0.87	0.89	0.82	0.85	0.65	0.94	0.40	0.31	0.83	0.69	0.81
adj. R^2	0.85	0.86	0.88	0.81	0.84	0.63	0.94	0.36	0.27	0.82	0.66	0.79
Resid. sd	0.45	0.47	0.57	0.66	4.36	1.19	0.45	0.02	12.71	0.24	15.16	13.77

Robust standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

ELF is significantly correlated with many of the health outcomes examined even after controlling for GDP per capita, regime type, malaria prevalence, and regional effects. In general, ELF is associated with poor health incomes, including higher infant mortality, higher maternal mortality, higher fertility, lower life expectancy, lower public expenditure on health, and more life years lost to disability. There does not appear to be a strong relationship between ELF and per capita health spending, change in maternal mortality, immunization rates, birth attendance, or access to improved sanitation facilities, at least in the world sample of countries.

GDP per capita and regime type appear to be strong predictors of most of the health outcomes, and health outcomes in Africa are significantly worse than the baseline (save for greater public health expenditure and per capita health spending). Higher GDP per capita and higher polity scores (indicating that a country is more democratic) are associated with lower infant, child and maternal mortality, lower total fertility, longer life expectancy, and greater per capita health spending. GDP per capita is also significantly negatively correlated with DALYs, and positively correlated with birth attendance and access to improved sanitation. Polity score, but not GDP per capita, is associated with higher public health expenditure. After controlling for regional effects, malaria prevalence remains a strong predictor only of total fertility and access to improved sanitation facilities, as well as weakly associated with lower immunization rates and lower birth attendance.

In the world sample of countries, the basic model fits certain health outcome dependent variables much better than others. In particular, the basic model explains much of the worldwide cross-national variation in infant and child mortality, maternal mortality, total fertility, life expectancy, per capita health spending, and DALYs. The basic model explains much less of the worldwide variation annual change in maternal mortality and immunization rates.

Since the most ethnically diverse countries in the world are found in Africa, I also test the relationship between ELF and health outcomes in the sample of countries excluding Africa. The results are very similar to those in which African countries are included in the analysis, and can be found in the Appendix A.2, Table 11.

Next I add to the basic model three variables related to the quality of institutions and policy: control of corruption, female education, and road density. Easterly and Levine (1997) and Alesina et al (2003) argue that the negative relationship they find between ELF and economic growth is largely due to the relationship between ELF and intermediating policy and institutional variables. They argue that ethnically diverse countries tend to have poor quality institutions and policies, which have a direct and detrimental effect on economic growth. I have chosen to examine the effect of the three variables, corruption, education, and roads, because they are both indicative of the quality of institutions and policy, and have been shown in past research to have significant effects on health outcomes in cross-national studies. Table 2 first shows the simple relationship between ethnic diversity and these three variables, in addition to the relationship with GDP per capita and malaria prevalence. This is similar to Table 6 in Easterly and Levine (1997) and Table 7 in Alesina et al (2003).

Table 2: Ethnic Diversity as a Determinant of Intermediating Variables

	GDPpc	Malaria	Corruption	Education	Roads
(Intercept)	9.52^{***}	0.04	0.38^{*}	98.59^{***}	95.07^{***}
	(0.19)	(0.05)	(0.15)	(3.03)	(18.58)
ELF	-1.85^{***}	0.82^{***}	-1.24^{***}	-34.07^{***}	-59.77
	(0.35)	(0.11)	(0.26)	(7.14)	(51.50)
N	158	154	158	130	129
R^2	0.16	0.26	0.12	0.17	0.02
adj. R^2	0.16	0.26	0.11	0.16	0.01
Resid. sd	1.16	0.38	0.94	20.89	123.18

Robust standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

While ELF is a significant predictor of GDP per capita, malaria prevalence, control of corruption and female education in this simple relationship, ELF is not a good predictor of road density.

In the full model, I thus include a number of variables related to the quality of policy and institutions in an attempt to determine whether a similar causal chain is at work in the relationship between ethnic diversity and health outcomes. These variables include female completion rate of primary school, control of corruption, and road density. I also include controls for several other variables which may affect health outcomes, including inequality (gini), official development assistance per capita, and rural population as a percentage of the total population. Table 3 presents the results of cross-national regression analysis of the full model for infant, child and maternal mortality, total fertility, change in maternal mortality, and life expectancy. Table 4 presents the results for the remaining health outcome variables, including public health expenditure, health spending per capita, immunization rates, DALYs, and birth attendance.

It is important to note that as in Easterly and Levine (1997) and Alesina et al (2003), the cross-sectional nature of these regressions make them very sensitive to model specification. Although many country observations are lost due to lack of data for certain control variables, ELF remains significantly correlated with infant mortality, child mortality, and public health expenditure, and more weakly correlated with total fertility and health spending per capita. Nevertheless, the effect of ethnic diversity on health outcomes is greatly reduced by the addition of variables controlling for quality of institutions and policies.

Table 3: Ethnic Diversity, Mortality and Fertility in the World, Full Model

	IMR	Under-5	MMR	TFR	Change	Life
(Intercept)	4.71**	4.62**	6.81**	5.50**	−0.19***	61.85***
	(1.42)	(1.60)	(2.23)	(1.62)	(0.05)	(15.96)
ELF	0.45*	0.49*	0.53	0.61†	−0.00	−0.75
	(0.20)	(0.22)	(0.37)	(0.35)	(0.01)	(1.97)
GDPpc	−0.22	−0.20	−0.25	−0.24	0.02*	1.25
	(0.13)	(0.15)	(0.22)	(0.16)	(0.01)	(1.45)
Avg. Polity	−0.04**	−0.03*	−0.02	−0.01	0.00*	0.14
	(0.01)	(0.01)	(0.02)	(0.02)	(0.00)	(0.11)
Malaria	0.05	0.03	−0.19	0.81*	−0.01	2.86
	(0.23)	(0.25)	(0.40)	(0.32)	(0.02)	(2.79)
Education	−0.00	−0.00	−0.01†	−0.01*	−0.00	0.04
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.03)
Corruption	−0.31*	−0.28*	−0.26	0.08	−0.01†	1.22
	(0.12)	(0.12)	(0.16)	(0.11)	(0.01)	(1.01)
Road	0.00	0.00	0.00	−0.00	−0.00	−0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Gini	0.01	0.01	0.02†	−0.01	0.00†	−0.11
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.13)
ODApc	0.00	0.00	0.00	−0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)
Rural	0.01	0.01	0.00	0.00	−0.00	−0.08†
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.05)
War Years	0.00	0.00	−0.00	0.01	0.00	−0.05
	(0.01)	(0.01)	(0.02)	(0.02)	(0.00)	(0.10)
E. Europe	−0.39†	−0.33	−1.30**	0.05	0.00	0.10
	(0.22)	(0.28)	(0.44)	(0.27)	(0.01)	(2.15)
L. America	0.23	0.14	−0.50	0.92**	−0.01	2.16
	(0.25)	(0.27)	(0.44)	(0.30)	(0.01)	(2.76)
NAME	0.09	0.09	−0.70	0.92*	−0.02	1.28
	(0.22)	(0.27)	(0.46)	(0.37)	(0.01)	(2.32)
Africa	0.41*	0.64**	0.60*	1.51***	0.04**	−12.90***
	(0.20)	(0.20)	(0.29)	(0.26)	(0.01)	(2.02)
West	−0.18	−0.27	−1.18*	0.45	0.02	2.86
	(0.35)	(0.37)	(0.55)	(0.34)	(0.01)	(2.64)
N	93	93	93	93	93	93
R^2	0.93	0.93	0.92	0.91	0.63	0.92
adj. R^2	0.91	0.92	0.91	0.89	0.55	0.90
Resid. sd	0.35	0.37	0.54	0.52	0.02	3.46

Robust standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Higher rates of female completion of primary school are weakly correlated with good health outcomes, including lower maternal mortality, lower fertility, higher immunization rates and greater birth attendance. Control of corruption is significantly correlated with a number of outcomes. Better control of corruption is associated with lower infant and child mortality, greater public health expenditure as a percentage of GDP,

Table 4: Ethnic Diversity and Health Outcomes in the World, Full Model

	Expend.	Healthpc	Immune	DALY	Birth	Sanit.
(Intercept)	3.32	−2.08	95.64**	10.56***	−6.25	−5.50
	(3.07)	(1.34)	(34.07)	(0.77)	(80.64)	(53.42)
ELF	−1.35*	−0.44†	−10.19	0.12	−11.31	−3.87
	(0.57)	(0.24)	(7.51)	(0.10)	(10.32)	(9.38)
GDPpc	−0.10	0.76***	−3.17	−0.08	6.37	7.38
	(0.31)	(0.14)	(4.71)	(0.07)	(7.43)	(5.18)
Avg. Polity	0.05†	0.03*	0.03	−0.00	0.55	0.30
	(0.03)	(0.01)	(0.37)	(0.01)	(0.51)	(0.41)
Malaria	−0.01	0.09	−3.53	0.06	−8.43	−0.63
	(0.58)	(0.23)	(6.37)	(0.12)	(13.47)	(9.12)
Education	0.00	−0.00	0.32†	−0.00†	0.38*	0.25
	(0.01)	(0.00)	(0.18)	(0.00)	(0.18)	(0.17)
Corruption	1.09***	0.43***	3.89	−0.06	−0.22	1.77
	(0.29)	(0.10)	(2.64)	(0.05)	(5.61)	(3.49)
Road	−0.00	−0.00	−0.01	0.00	−0.01	−0.03
	(0.00)	(0.00)	(0.03)	(0.00)	(0.02)	(0.07)
Gini	−0.02	0.01	0.05	0.00	0.29	−0.32
	(0.02)	(0.01)	(0.23)	(0.01)	(0.48)	(0.28)
ODApc	0.00	−0.00	−0.01	0.00	0.02	−0.02
	(0.00)	(0.00)	(0.02)	(0.00)	(0.06)	(0.04)
Rural	0.00	−0.01*	−0.02	0.00*	−0.36	−0.13
	(0.01)	(0.00)	(0.09)	(0.00)	(0.25)	(0.20)
War Years	−0.00	−0.00	−0.47	0.00	−0.38	0.06
	(0.03)	(0.01)	(0.40)	(0.01)	(0.47)	(0.49)
E. Europe	1.72**	0.88**	0.99	0.09	8.33	19.33*
	(0.56)	(0.28)	(5.92)	(0.11)	(12.36)	(8.13)
L. America	1.60*	0.33	−4.69	−0.03	−9.43	10.44
	(0.66)	(0.30)	(6.19)	(0.12)	(14.11)	(9.64)
NAME	0.94	0.67*	−0.01	−0.10	3.47	13.76
	(0.59)	(0.26)	(5.75)	(0.12)	(10.86)	(8.58)
Africa	1.56**	0.31	−0.51	0.52***	12.30	−8.96
	(0.50)	(0.20)	(5.33)	(0.11)	(9.66)	(7.84)
West	2.19**	1.35***	−5.89	−0.05	−2.71	11.49
	(0.68)	(0.34)	(6.32)	(0.13)	(15.68)	(10.50)
N	93	93	93	93	71	84
R^2	0.76	0.96	0.51	0.92	0.78	0.86
adj. R^2	0.71	0.96	0.41	0.91	0.72	0.83
Resid. sd	1.10	0.39	10.43	0.18	14.01	12.94

Robust standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

and greater per capita health spending. Inequality is not a strong predictor of any of the health outcomes examined here, but is weakly correlated with higher maternal mortality and increasing in maternal mortality over time. The effect of malaria on health outcomes is even weaker than in the basic model, with malaria a significant predictor only of total fertility. Larger rural populations are associated with lower per capita health spending and higher DALYs. Development aid and war years appear to have little if any effect on health outcomes in this model.

The full model appears to be a slightly better fit for the most of the health outcome variables, as the adjusted R square is slightly larger for all health outcomes in the full model than in the basic model. However, except for control of corruption and female education, most of the additional control variables have little effect on health outcomes and do not add much value to the analysis. Even where control of corruption does appear to have an effect on health, as with infant or child mortality, ELF still exhibits an independent effect, although the coefficient for ELF is smaller in the full model than the basic model.

Perhaps most importantly, there appears to be an "Africa effect" on numerous health outcomes that persists even after the inclusion of a myriad of control variables. African countries tend to have higher child and maternal mortality, higher fertility, increases in maternal mortality, lower life expectancy, and higher DALYs relative to the baseline (Asia in this specification) even after controlling for country wealth, regime type, and war, among other controls. Surprisingly, then, African countries tend to spend more on public health as a percentage of GDP than Asian countries, while per capita health spending is not different between the two regions after adding the controls. This finding alone suggests that there is need to examine the determinants of health outcomes on a regional basis, and in particular for African countries.

4.1 Ethnic Diversity and Health Outcomes by Region

Next I examine the relationship between ethnic diversity and health outcomes by region. In general, I find that while ethnic diversity appears to have a strong effect on health outcomes in the world sample of countries, ethnic diversity does not explain much of the variation in health outcomes within regions. GDP per capita remains the strongest predictor of health outcomes within regions. Nevertheless, the ELF remains significantly correlated with certain health outcomes, such as infant mortality, within certain regions. Table 5 shows the results for infant mortality by region.

Table 5: Ethnic Diversity and Infant Mortality by Region

	World	World	World	Africa	Africa	LA	Asia	NAME	E. Europe	West
(Intercept)	7.42***	7.26***	7.00***	4.29***	5.61***	6.26**	7.96***	8.07***	9.03***	−0.58
	(0.48)	(0.46)	(0.46)	(0.59)	(0.48)	(1.87)	(0.90)	(0.76)	(1.27)	(2.79)
ELF	0.92***	0.74***	0.78***	0.24	0.35	0.60	0.30	0.92†	0.28	0.79**
	(0.18)	(0.18)	(0.17)	(0.23)	(0.23)	(0.44)	(0.50)	(0.46)	(0.50)	(0.23)
GDPpc	−0.52***	−0.49***	−0.40***	−0.08	−0.18**	−0.49*	−0.66***	−0.56***	−0.61***	0.18
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.20)	(0.11)	(0.08)	(0.13)	(0.26)
Avg. Polity	−0.03***	−0.04***	−0.03***	−0.01	−0.02†	0.05†	0.01	−0.05***	−0.07***	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)	(0.01)	(0.02)
Malaria	0.47**	0.27†	0.23	0.64**		0.10	0.96*			
	(0.15)	(0.16)	(0.16)	(0.20)		(0.39)	(0.38)			
Africa		0.44**								
		(0.13)								
Regional Dummies	*NO*	*NO*	*YES*							
N	152	152	152	43	44	23	21	20	25	21
R^2	0.81	0.82	0.86	0.45	0.28	0.53	0.82	0.79	0.80	0.45
adj. R^2	0.80	0.82	0.85	0.39	0.23	0.43	0.77	0.75	0.78	0.35
Resid. sd	0.52	0.50	0.45	0.32	0.35	0.44	0.48	0.36	0.41	0.21

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

ELF remains a strong predictor of infant mortality in the West, and to a slightly lesser degree, in NAME. The relationship between ELF and infant mortality is quite weak in other regions however, including Africa. In this model, malaria prevalence is the only significant predictor of infant mortality in Africa. Although malaria prevalence and ELF are highly correlated in the global sample (0.51), they are somewhat less so within Africa (0.20), and thus ELF remains a poor predictor of infant mortality even after the removal of malaria prevalence as a control.

Clearly, the strength of relationship between ethnic diversity and infant mortality varies by region, as does the predictive power of income and regime type. However, the relationship between ELF and infant mortality (among other health outcomes) globally is robust to the addition of a binary indicator for Africa, and separately, to regional dummies. Thus, while the relationship varies by region, ELF remains a strong predictor of infant mortality in the world sample of countries. The relationship between ELF and the other health outcomes by region (not presented here) is similarly complex, suggesting that a more nuanced regional analysis may shed light on the variables that determine health outcomes in different parts of the world.

The relationship between ELF and infant mortality is also robust across income levels, with the exception of upper-middle income countries.[17] While the magnitude of the effect of GDP per capita and average polity score is similar for lower-middle, upper-middle and high income countries, the magnitude is much weaker among low income countries, where ELF appears to have a strong positive effect on infant mortality rates. Overall, ELF appears to have a strong effect on most health outcomes (including child and maternal mortality, fertility, life expectancy, change in maternal mortality, immunization rates, and DALYs) among low income countries, and on only certain health outcomes among other income levels. In almost all cases where ELF has a significant effect on health outcomes, higher ELF is associated with worse health outcomes.[18]

5 Ethnic Diversity and Health Outcomes in Africa

Here I examine further the effect of ethnic diversity on health outcomes focusing specifically on the sample of African countries, 31 of which are low-income countries. I begin with the basic model. Table 6 presents the results from the basic linear regression model.

[17] See Table 10 in the Appendix.

[18] There was insufficient space here to include empirical results by indicator, region and income level, but these analyses are available upon request.

Table 6: Ethnic Diversity and Health Outcomes in Africa, Basic Model

	IMR	Under-5	MMR	TFR	Life	Expend.	Healthpc	Change	Immune	DALY	Birth	Sanit.
(Intercept)	4.29***	4.82***	7.97***	5.76***	43.72***	3.12	−3.37**	0.03	140.59***	11.11***	−28.78	−32.08
	(0.59)	(0.67)	(1.06)	(1.41)	(11.33)	(2.40)	(0.99)	(0.05)	(31.44)	(0.56)	(42.55)	(29.44)
ELF	0.24	0.07	0.06	0.81	−0.34	−2.08*	0.15	0.02	−17.26	0.15	−3.38	6.65
	(0.23)	(0.26)	(0.41)	(0.55)	(4.39)	(0.93)	(0.38)	(0.02)	(12.19)	(0.22)	(15.02)	(11.41)
GDPpc	−0.08	−0.09	−0.23*	−0.41**	1.02	0.06	0.94***	−0.00	−4.90	−0.08	11.52*	8.67**
	(0.06)	(0.07)	(0.11)	(0.14)	(1.15)	(0.24)	(0.10)	(0.00)	(3.18)	(0.06)	(4.36)	(2.98)
Avg. Polity	−0.01	−0.02	−0.02	0.00	0.12	0.07	0.01	0.00	0.05	0.00	0.12	0.46
	(0.01)	(0.01)	(0.02)	(0.02)	(0.19)	(0.04)	(0.02)	(0.00)	(0.54)	(0.01)	(0.62)	(0.50)
Malaria	0.64**	0.70**	0.25	1.90***	0.87	−0.33	−0.28	−0.04*	−19.80†	0.22	−1.08	−11.31
	(0.20)	(0.23)	(0.36)	(0.48)	(3.85)	(0.81)	(0.34)	(0.02)	(10.68)	(0.19)	(15.31)	(10.00)
N	43	43	43	43	43	43	43	43	43	43	34	43
R^2	0.45	0.42	0.22	0.60	0.03	0.20	0.78	0.21	0.18	0.18	0.29	0.34
adj. R^2	0.39	0.36	0.13	0.56	−0.07	0.11	0.75	0.13	0.09	0.09	0.19	0.27
Resid. sd	0.32	0.36	0.57	0.76	6.09	1.29	0.53	0.03	16.89	0.30	16.33	15.81

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

While the signs on the coefficients for ELF are almost all consistent with the findings in the global model (higher ethnic diversity associated with worse health outcomes), the relationship between ELF and health outcomes is only statistically significant for public health spending, where ethnic diversity is associated with lower public health spending. Malaria prevalence is a strong predictor of a number of health outcomes, particularly infant and child mortality, as well as total fertility. Interestingly, malaria prevalence is also negatively correlated with change in maternal mortality, meaning that high malaria prevalence is associated with a reduction in maternal mortality. It is possible that countries with the highest malaria prevalence also had very high initial maternal mortality, and thus were able to experience the greatest improvement in maternal mortality over time.

GDP per capita is also a good predictor of a number of outcomes in the basic model, namely maternal mortality, total fertility, per capita health spending, birth attendance and access to improved sanitation facilities. Polity scores do not appear strong predictors of any health outcome in Africa. While the basic model appears to be a reasonably good fit for certain indicators, such as total fertility and per capita health spending, with an r-square of 0.60 and 0.78 respectively, the basic model explains little of the variation in other health outcomes, such as life expectancy, public health expenditure, immunization rates and DALYs.

While ELF appears to have little effect on health outcomes within the sample of African countries, I again examine the relationship between ELF and the three intermediating variables female education, corruption and roads, as well as with malaria and GDP per capita, within the Africa sample. Table 7 presents the simple relationship between ELF and these five dependent variables:

Table 7: Ethnic Diversity as a Determinant of Intermediating Variables within Africa

	GDPpc	Malaria	Corruption	Education	Roads
(Intercept)	7.47***	0.70***	−0.50*	65.11***	32.59***
	(0.40)	(0.13)	(0.23)	(8.89)	(9.08)
ELF	0.19	0.25	−0.30	−8.64	−25.52†
	(0.59)	(0.19)	(0.33)	(13.13)	(13.13)
N	45	44	45	39	38
R^2	0.00	0.04	0.02	0.01	0.10
adj. R^2	−0.02	0.02	−0.00	−0.02	0.07
Resid. sd	0.97	0.30	0.55	19.74	18.26

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Although globally there is a strong relationship between ELF and GDP per capita, malaria prevalence, control of corruption and education (Table 2), within Africa there appears to be no relationship between ELF and these potential intermediating variables (Table 7). There is a weak negative relationship between

ELF and road density within Africa, which is interesting since road density was the only variable in Table 2 for which ELF was not a strong predictor in the world sample.

In the full model for the Africa sample, I include controls for education, control of corruption and road density. Based on the weak or nonexistent relationship between ELF and these variables within Africa, any effect these variables have on health outcomes is not likely an indirect effect of ELF, with the possible exception of road density. Rather, these variables may have independent effects on health outcomes. Table 8 presents the results of the full model, with controls added for female primary school completion rate, control of corruption, road density and rural population as a percentage of total population. I also include a control for HIV prevalence, a virus that is a major cause of death and disability in Africa. I have omitted the controls for ODA per capita and war years as they were not significant for any of the dependent variables in either the Africa or the world sample.

The effect of ELF on health outcomes appears quite different upon the inclusion of additional control variables. Although they are not statistically significant, some the coefficients for ELF have switched signs. Specifically, ELF is now associated with lower infant, child and maternal mortality. Due to the small sample size, any conclusions drawn from this analysis must be tentative, but the weak relationship between ELF and the control variables within the Africa sample suggests that ELF is simply not a good predictor of health outcomes in Africa.

Instead, the results suggest that a number of the control variables exhibit an effect on health outcome variables independently of ELF. Not surprisingly, HIV prevalence is associated with higher maternal mortality, lower life expectancy, greater public health expenditure, an increase in maternal mortality over time greater DALYs. HIV is also associated with higher rates of birth attendance, perhaps because countries with high HIV prevalence often target pregnant mothers for HIV testing and preventing mother-to-child-transmission (PMTCT) (Walker et al 2003). Countries with larger rural populations are more likely to have higher fertility rates and a lower percentage of mothers delivering with skilled birth attendants, although large rural populations are also associated with decreasing maternal mortality. Road density is negatively correlated with child and maternal mortality, and positively correlated with access to improved sanitary facilities. Better control of corruption is associated with lower infant mortality and a greater reduction in maternal mortality. GDP per capita appears to explain little of the variation in health outcomes in these models, although it is a significant predictor of per capita health spending and birth attendance. Average polity scores are poor predictors of health outcomes within Africa in this model, as is female education.

Table 8: Ethnic Diversity and Health Outcomes in Africa, Full Model

	IMR	Under-5	MMR	TFR	Life	Expend.	Healthpc	Change	Immune	DALY	Birth	Sanit.
(Intercept)	4.93***	4.49***	7.07***	5.31†	59.28**	−0.86	1.10	−5.41	108.13†	11.19***	10.74	−7.38
	(1.04)	(0.99)	(1.73)	(2.64)	(19.78)	(4.52)	(2.13)	(5.29)	(56.38)	(1.02)	(50.01)	(68.14)
ELF	−0.29	−0.30	−0.80†	1.30†	7.27	−1.12	0.30	0.02	−16.09	0.01	−7.45	13.17
	(0.26)	(0.25)	(0.44)	(0.67)	(5.01)	(1.15)	(0.54)	(1.34)	(14.29)	(0.26)	(12.18)	(17.27)
GDPpc	−0.09	−0.05	−0.07	−0.44†	0.33	−0.28	0.45*	0.41	−4.73	−0.13	9.51*	2.08
	(0.09)	(0.09)	(0.15)	(0.23)	(1.73)	(0.39)	(0.19)	(0.46)	(4.92)	(0.09)	(4.47)	(5.95)
Avg. Polity	−0.01	−0.00	0.02	−0.01	−0.04	0.05	−0.01	0.18**	−0.74	0.01	0.08	0.33
	(0.01)	(0.01)	(0.02)	(0.03)	(0.20)	(0.05)	(0.02)	(0.05)	(0.57)	(0.01)	(0.48)	(0.68)
Malaria	0.32	0.57*	0.56	1.14	−5.00	3.04*	0.22	1.33	7.67	0.32	22.82	−5.20
	(0.27)	(0.26)	(0.45)	(0.69)	(5.15)	(1.18)	(0.55)	(1.38)	(14.66)	(0.26)	(13.69)	(17.72)
Education	−0.00	−0.00	−0.01	−0.01	0.03	0.01	−0.00	−0.03	0.40†	−0.00	−0.06	0.13
	(0.00)	(0.00)	(0.01)	(0.01)	(0.07)	(0.02)	(0.01)	(0.02)	(0.19)	(0.00)	(0.17)	(0.23)
Corruption	−0.39*	−0.25	−0.47†	0.24	4.11	0.79	0.68†	−1.97*	9.41	−0.15	11.00	−5.80
	(0.16)	(0.15)	(0.27)	(0.41)	(3.07)	(0.70)	(0.33)	(0.82)	(8.74)	(0.16)	(7.85)	(10.56)
Roads	−0.00	−0.01**	−0.02**	−0.01	0.06	0.02	0.01	−0.01	0.26	−0.00	0.27†	0.52*
	(0.00)	(0.00)	(0.01)	(0.01)	(0.06)	(0.01)	(0.01)	(0.02)	(0.16)	(0.00)	(0.14)	(0.20)
Rural	0.00	0.01	−0.00	0.03**	−0.07	0.03†	−0.01†	−0.05*	−0.09	0.00	−0.67**	−0.16
	(0.00)	(0.00)	(0.01)	(0.01)	(0.07)	(0.02)	(0.01)	(0.02)	(0.21)	(0.00)	(0.18)	(0.26)
HIV	0.01	0.02	0.05**	−0.01	−0.50*	0.16**	0.04†	0.40***	0.25	0.02*	1.10*	0.87
	(0.01)	(0.01)	(0.02)	(0.03)	(0.20)	(0.05)	(0.02)	(0.05)	(0.57)	(0.01)	(0.49)	(0.68)
N	30	30	30	30	30	30	30	30	30	30	27	30
R^2	0.80	0.84	0.78	0.81	0.58	0.66	0.79	0.86	0.57	0.61	0.77	0.50
adj. R^2	0.72	0.76	0.67	0.73	0.39	0.50	0.70	0.79	0.38	0.44	0.65	0.28
Resid. sd	0.24	0.23	0.40	0.61	4.58	1.05	0.49	1.23	13.06	0.24	10.58	15.79

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

The full model fits the data much better than does the basic model for African countries. This is in part because GDP per capita and polity scores, while strong predictors of health outcomes in the world sample of counties and certain regions, explain little of the variation in health outcomes in Africa. Control of corruption, roads, rural populations, and HIV prevalence are much stronger predictors of health outcomes in African countries. The weak effect of ethnic diversity on health outcomes in Africa, and the relatively strong effect of variables such as road density and rural population, suggest that state capacity to reach the population and deliver services is a far greater determinant of health outcomes than is ethnic diversity at the national level.

6 Ethnic Diversity and Health Care Provision in Uganda

In this section, I conduct an analysis of the relationship between ethnic diversity and health outcomes in Africa at a sub-national level. This analysis examines within-country variation in health outcomes in a single African country, Uganda. Uganda is a highly ethnically heterogeneous country. It is the third most heterogenous country in the world according the *Atlas* data, the fourth according to Fearon's (2003) data, and the seventh (in Africa) according to Posner's (2004) PREG data. The 2002 national census includes 57 ethnic categories, which I have used to construct ELF scores for each of Uganda's districts. The immunization coverage is calculated as a percentage of coverage over three years, 2007-2009, and the immunization average is an average of coverage of the four vaccines over the same time period. Pit latrine coverage is used as a proxy for access to improved sanitation facilities and data is from 2007. Health Center is the number of government health centers (levels II, III and IV) in the year 2009 and Hospital is the number of government hospitals in the district in 2006. Ethnic diversity varies greatly across districts, as can be seen in Figure 5, and districts in the central region tend to be more diverse than elsewhere (a boxplot of ELF by region can be found in Appendix A.2, Figure 11).

The initial analysis in Table 9 suggests that in Uganda, higher ethnic diversity is associated with lower immunization coverage at the district level, but is not a significant predictor of pit latrine coverage, or the number of health centers or hospitals. Population however, is unsurprisingly a very strong predictor of the number of health centers and hospitals, as is pit latrine coverage. Northern Uganda performs poorly across almost all health indicators, relative to the central region. This is likely in part due to the fact that the northern region has only recently emerged from a more than twenty year period of conflict, during which public goods provision was severely hampered.

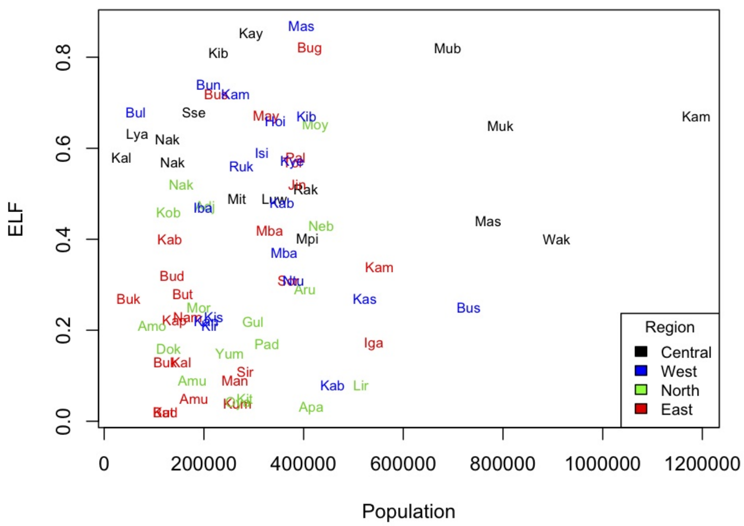

Figure 5: Districts by ELF and Population in Uganda

Table 9: Ethnic Diversity and Health Care Provision in Uganda

	BCG	OPV3	Measles	DPT3	Immune Avg.	Latrine	Health Center	Hospital
(Intercept)	292.15**	115.44*	187.75*	252.54***	211.97***	−45.58	−361.44***	−15.04***
	(100.73)	(46.46)	(78.43)	(60.19)	(52.94)	(31.24)	(42.33)	(3.01)
ELF	−22.12	−38.71**	−62.48**	−36.94*	−40.06**	−2.99	−10.89	−0.19
	(25.31)	(11.68)	(19.71)	(15.13)	(13.30)	(7.85)	(10.64)	(0.76)
log(Pop)	−15.22†	−0.85	−5.58	−11.28*	−8.23†	9.18***	33.95***	1.39***
	(7.91)	(3.65)	(6.16)	(4.73)	(4.16)	(2.45)	(3.33)	(0.24)
East	12.91	−1.91	−4.46	−7.20	−0.17	−9.11†	−18.15**	−0.93†
	(16.17)	(7.46)	(12.59)	(9.66)	(8.50)	(5.01)	(6.79)	(0.48)
North	−16.06	−18.55*	−26.93†	−22.63*	−21.04*	−22.68***	−26.36***	−0.73
	(17.78)	(8.20)	(13.84)	(10.62)	(9.34)	(5.51)	(7.47)	(0.53)
West	−2.78	−6.83	−2.82	−12.03	−6.12	4.28	−13.80*	−1.09*
	(15.35)	(7.08)	(11.96)	(9.17)	(8.07)	(4.76)	(6.45)	(0.46)
N	76	76	76	76	76	76	76	76
R^2	0.13	0.20	0.17	0.19	0.24	0.45	0.65	0.39
adj. R^2	0.07	0.14	0.12	0.13	0.18	0.41	0.62	0.34
Resid. sd	44.20	20.39	34.42	26.41	23.23	13.71	18.57	1.32

Standard errors in parentheses

† significant at $p < .10$; $^*p < .05$; $^{**}p < .01$; $^{***}p < .001$

Figure 6 shows the relationship between immunization coverage (of all four vaccines) and ethnic diversity by region.[19]

[19] A number of districts have immunization rates that are above 100%. It is difficult to know how to interpret these figures, but there are a few possibilities. One is that some people who do not reside in the district are nonetheless immunizing their children in the district. This could mean they are traveling across districts, or traveling across the border from the Democratic

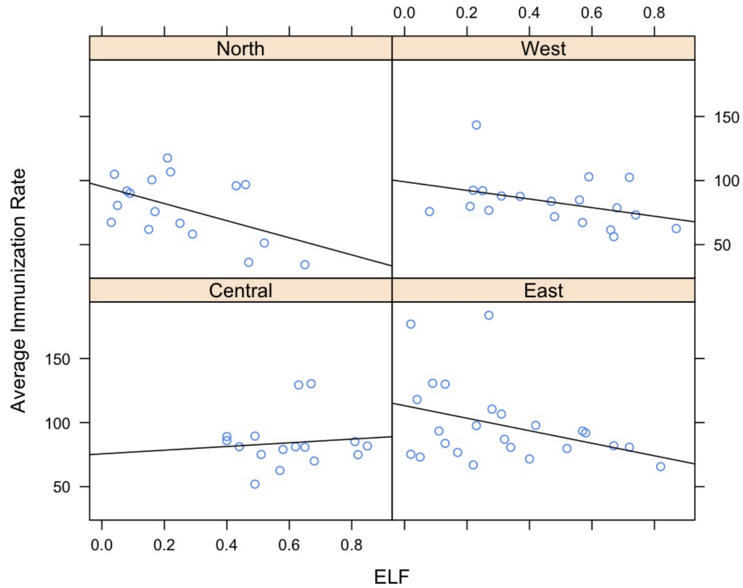

Figure 6: District Level Ethnic Diversity and Immunization by Region in Uganda

It is interesting to note that while ethnic diversity is associated with lower immunization coverage, it does not seem to have an effect on health infrastructure, namely latrines and physical health facilities. It is possible that while it is relatively easy for the government to build health facilities based on population size and without regard to ethnicity, the day to day provision of health care (i.e. the immunization of children) is much more sensitive to local collective action that may be impaired by ethnic diversity at the district level. The Uganda National Extended Program on Immunization (UNEPI), run by the Ministry of Health, created a set of standards for the national immunization program at the national, district, and health facility level. While the Central UNEPI Division (national level) is responsible for creating policy, procuring vaccines at the national level, and monitoring policy implementation, it is important to note that the districts are responsible for keeping vaccines in stock, storing vaccines at the correct temperature, distributing vaccines to health units and organizing outreach activities to ensure all children in the district are immunized (Uganda Ministry of Health 2003).

Thus, the district plays a central role in ensuring that immunization policy is translated into the physical immunization of children. It is possible that districts that are more ethnically diverse have greater difficulty reaching and incorporating ethnically distinct communities into immunization activities. If levels of mistrust

Republic of Congo, Sudan, Kenya, or Rwanda. Including a control for "border district" or "percent non-Ugandan" may shed some light on the plausibility of the latter, and some control for spatial autocorrelation could help with the former. A second possibility is that children who are above one year of age are being vaccinated, increasing the number of children receiving vaccinations relative to the number expected to receive vaccinations. Other suggestions or interpretations here are welcome.

between groups are high (relative to within group trust in more ethnically homogenous districts) parents may be less likely to take their children to be immunized, an activity that already raises some suspicion among parents worldwide (Diekema 2005, Wilson and Marcuse 2001). Additionally, if we consider Habyarimana et al's technology mechanism, the "findability" by district officials or health workers of mothers with newborn children may be lower in districts that are more ethnically diverse. While much more work is needed for the sub-national analysis, including collection of data on other district level control variables, district case study research, and sub-national analyses of more than one country, the evidence thus far suggests ethnic diversity at the sub-national level may explain some variation in particular health outcomes within countries. Outcomes that are particularly sensitive to local collective action, such as day-to-day activities (immunization) rather than one-time infrastructure construction (health centers), may be more severely affected by ethnic diversity.

7 Discussion

The ability of citizens to access health facilities and health workers, on the one hand, and the ability of the state to reach its far flung populations, on the other, proxied by road density and size of rural population, appear to be important determinants of cross-national variation in mortality and morbidity on the African continent. The challenge of reaching remote and rural populations is well recognized by many African leaders. During the July 2010 African Union Summit, whose theme was Maternal, Infant and Child Health and Development in Africa, the issue of road infrastructure and access to healthcare dominated much of the discussion amongst African heads of state and ministers of health.

As Tanzanian president Jakaya Kikwete succinctly announced at the summit, "Our biggest problem is inadequate access to health care facilities."[20] Tanzania is a large country with scattered and non-contiguous areas of high population density, making the extension of state power, and thus the extension of public goods and services, a major challenge. It is perhaps unsurprising then, that variables related to access remained significant predictors of health outcomes in Africa even after including numerous control variables. Countries whose road density allows for easier access to populations and facilities tend to have lower rates of child and maternal mortality, higher percentages of mothers delivering with a skilled birth attendant, and higher percentages of their populations with access to improved sanitation facilities.

Control of corruption is also important for health outcomes, but as previously noted, does not appear to

[20] In a presentation to the meeting of the heads of state at the 15th Ordinary Session of the Assembly of the African Union, on July 26, 2010, in Kampala, Uganda.

be an intermediating variable between ethnic diversity and health within the African sample of countries. The correlation between average control of corruption and ELF is -0.34, and the correlation within Africa is only -0.14. Thus, while corruption may be detrimental to certain health outcomes in Africa, greater corruption is not primarily the result of greater ethnic diversity. Additionally, other potential intermediating variables examined here do not appear to link ELF to health outcomes. Road density is fairly weakly correlated with ELF in Africa (-0.31), HIV prevalence is not correlated at all (-0.04), and rural population is negatively correlated with ethnic diversity (-0.27).

Using the alternative specifications for ethnic diversity, ELF2 and PREG, yielded similar results for the basic model within Africa. However, in the full model, higher values of PREG were associated with significantly lower child mortality and higher life expectancy (see Appendix Table 12). This relationship is the opposite of what was observed in the global model. While I do not have a good explanation for this finding, it may be a fruitful area for further research, and is a puzzle in and of itself.

This analysis has used the broad-brush approach of applying the same model regardless of the specific health dependent variable. The advantage to this approach is that it points to the factors that have an effect on many or all health outcomes, as well as to those that have universally little or no effect on health. This approach has thus highlighted the widespread effect of HIV, road density, rural population, and control of corruption on a variety of health outcomes, as well as the weak or nonexistent role of ethnic diversity and country wealth in explaining variation in health outcomes within Africa.

The downside to this approach is that each health outcome is likely determined by a different, and possibly unique, combination of factors, and each thus deserves its own in-depth analysis. For example, nearly two thirds of maternal deaths in Africa are the result of complications around the time of childbirth, including hemorrhage, hypertension, sepsis, and obstructed labor (Khan et al 2006), that can often be easily resolved with proper medical staff and equipment - but only if the mother can reach a clinic, or if the clinic can reach the mother. This may in part explain why road density may be a particularly powerful determinant of maternal mortality, while road density may be a more distant or indirect determinant of a health outcome such as total life expectancy. Still, the broad-brush approach has been useful in demonstrating the weakness of ethnic diversity as a determinant of health outcomes in Africa.

The findings within Uganda suggest that although ethnic diversity does not explain much cross-national variation within health outcomes in Africa, it may still have a significant effect on health care provision at the sub-national level. Whether ethnic diversity leads to aggregate poor performance at the national level may be determined in part by the extent to which sub-national administrative units are heterogeneous. In the absence of a more comprehensive cross-national and sub-national ELF dataset, it is difficult to know to what extent heterogeneous countries are also locally heterogeneous, but this is clearly a fruitful area for future research.

8 Conclusion and Implications

While ethnic diversity is a strong predictor of many health outcomes in the world sample of countries, the relationship between ethnic diversity and health varies by region, by income level, and by health indicator. Although the relationship between ethnic diversity and a number of health outcomes is quite robust among the global sample of countries and among low income countries, it is quite weak among the sample of African countries. Perhaps because the majority of the countries in Africa are low income countries, GDP per capita also explains little of the variation in health outcomes among African countries. Moreover, the quality of institutions as measured by a countrys level of democratization is not a good predictor of health outcomes in Africa.

Among African countries, factors which may be considered aspects of state capacity, such as road density, and quality of institutions, such as control of corruption, explain far more of the variation in health outcomes than does a countrys ethnic diversity, GDP per capita, or level of democratization. The ability of African governments to access their populations, and the ability of populations to access health facilities, appears to be a crucial determinant of child and maternal mortality on the continent. Where African countries have more kilometers of road per square kilometer of land, child and maternal mortality rates are lower, and access to skilled birth attendants and improved sanitation facilities is higher, even after controlling for a wide range of other factors. Not surprisingly, the disease burden of HIV and malaria also contributes significantly to death and disability in Africa.

That ethnic diversity is not a good predictor of health outcomes in Africa is somewhat surprising, given the large and growing literature on ethnic diversity and public goods provision, particularly in African villages, cities and communities. Part of the explanation for this seeming disconnect may lie in the in the distinction between heterogeneous countries and heterogeneous communities. While heterogeneous communities may face problems of collective action, heterogeneous countries, particularly in Africa, may be comprised of primarily homogenous communities. Within Uganda, one of the most heterogeneous countries in the world, I found great variation in district level ethnic diversity. Whether Ugandan districts are more or less heterogeneous, on average, than those of other countries cannot be known until a more complete dataset on sub-national ELF is constructed. It may also be useful to consider potential determinants of sub-national ethnic diversity, which is likely to change at a faster rate than national level ethnic diversity.

The best predictors of health outcomes in Africa examined in this paper, including HIV, control of corruption, road density, and rural population, are only very weakly correlated with ethnic diversity. While this finding is somewhat unexpected, given the findings of Alesina et al (2003), Mauro (1995) and others, it is also hopeful. Countries cannot easily change their ethnic composition (nor would many want to, given the many benefits that can arise from having a diverse population), but they can improve their road infrastructure and control of corruption. Although the time invariant nature of the variable ELF made a time series analysis infeasible in this paper, since ELF does not appear to be a significant predictor of health outcomes in the Africa sample, it may be worthwhile to conduct a time series analysis looking more closely at control of corruption and other time varying factors, as well as to examine changes in health variables over time.

Although ELF is not a good predictor of health outcomes in Africa, in the global model, ELF is fairly robust predictor of a wide range of health outcomes. Prevailing theories of the mechanisms underlying the relationship between ethnic diversity and dependent variables such as economic growth and public goods provision do not fully account for the results shown here. In the global model, the relationship between ELF and health outcomes such as infant and child mortality, and public health expenditure, is robust even after controlling for variables taking into account the quality of a country's institutions and policies. It also remains unclear whether the proposed mechanisms underlying the relationship between ethnic diversity and local public goods provision, such as strategy selection and technology, can account for the relationship between ethnic diversity and health outcomes at the national level.

The determinants of health outcomes worldwide may be far more complex than has been acknowledged in the relatively small political science literature on the subject. While political scientists have found ethnic diversity and regime type to be powerful determinants of health outcomes, the analysis presented here suggests that the relationship between these variables may differ significantly by region and income level. The primary determinants of health outcomes, both direct and indirect, may be unique to regions and income levels, and future research should examine each more thoroughly.

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A Appendix

A.1 Health Outcomes: Coding and Definitions

Infant Mortality

The number of infants per 1000 who die before reaching one year of age in a given year. Year: 2008 Source: WDI.

ΔIMR

The percentage change in infant mortality rate from the year 2000 to 2009. Year: 2000, 2009 Source: WDI.

Under-5 Mortality

The number of children per 1000 who die before reaching five years of age in a given year. Year: 2010 Source: IHME

Maternal Mortality Rate

The number of women per 100,000 who die during pregnancy, childbirth or in the first 42 days after delivery in a given year. Year: 2008 Source: IHME

Total Fertility Rate

The number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. Year: 2008 Source: WDI

Life Expectancy

The number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Year: 2008 Source: WDI

Public Health Expenditure

Average public health expenditure as a percentage of GDP from 2003-2007. Years: 2003-2007 Source: WDI

Per Capita Health Expenditure

Total health expenditure (public and private) as a ratio of the total population. Year: 2007 Source: WDI

Change in Maternal Mortality

Yearly rate of decline in maternal mortality rate between 1990 and 2008. Years: 1990-2008 Source: IHME

Immunization

The percentage of children ages 12-23 months who received vaccinations for diphtheria, pertussis, and tetanus (DPT) before 12 months or at any time before the survey. A child is considered fully immunized against DPT after receiving three doses of vaccine. Year: 2008 Source: WDI

DALY

Estimated disability-adjusted life years (DALYs) for all causes per 100,000 population. Year: 2004 Source: WHO

Birth Attendance

The percentage of deliveries attended by personnel trained to give the necessary supervision, care, and advice to women during pregnancy, labor, and the postpartum period; to conduct deliveries on their own; and to care for newborns. Year: various 2005-2008 Source: WDI

Access to Improved Sanitation

The percentage of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained. Year: 2006 Source: WDI

BCG

The percentage of children under one year of age who have received the BCG (bacille Calmette-Guerin) vaccine against tuberculosis, averaged over the years 2007 to 2009. Data collected by the Uganda National Expanded Program on Immunization (UNEPI).

OPV3

The percentage of children under one year of age who have received three doses of the OPV3 (oral polio vaccine) vaccine against polio, averaged over the years 2007 to 2009. Data collected by the Uganda National Expanded Program on Immunization (UNEPI).

Measles

The percentage of children under one year of age who have received the measles vaccine, averaged over the years 2007 to 2009. Data collected by the Uganda National Expanded Program on Immunization (UNEPI).

DPT3

The percentage of children under one year of age who have received three doses of the DPT-HepB-Hib (Diptheria, Pertusis, Tetanus, Hepatitis B, Heamophilus influenzae) vaccine, averaged over the years 2007 to 2009. Data collected by the Uganda National Expanded Program on Immunization (UNEPI).

Immune Average

An average of BCG, OPV3, Measles and DPT3 coverage from the years 2007-2009. Data collected by the Uganda National Expanded Program on Immunization (UNEPI).

Latrine

Percentage of households with access to pit latrines. Year: 2007. Source: Uganda Bureau of Statistics.

Health Center

Number of public health centers (includes Health Center II, III and IV) at the district level. Year: 2009. Source: Uganda Bureau of Statistics.

Hospital

Number of public hospitals at the district level. Year: 2006. Source: Uganda Bureau of Statistics.

A.2 Additional Tables and Figures

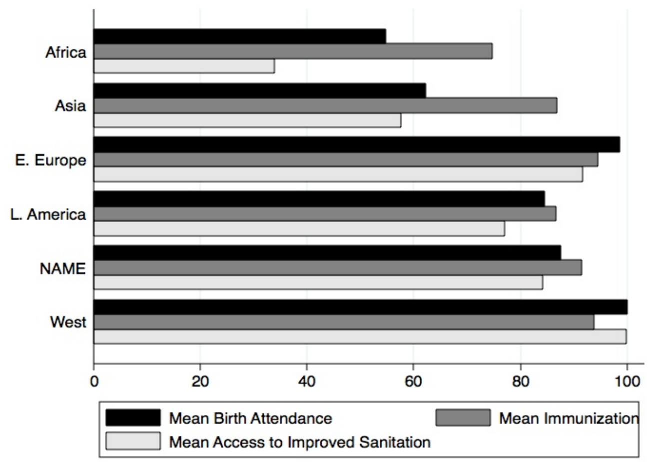

Figure 7: Immunization, Sanitation and Birth Attendance by Region

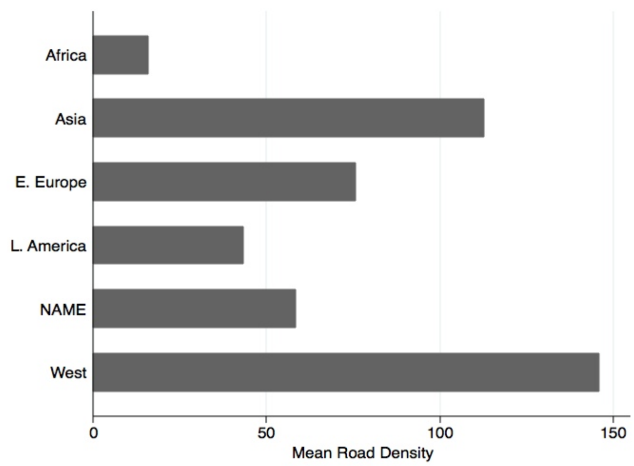

Figure 8: Mean Road Density by Region

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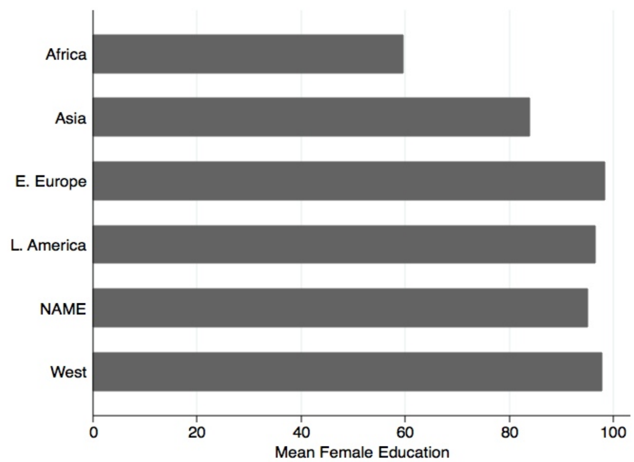

Figure 9: Female Education by Region

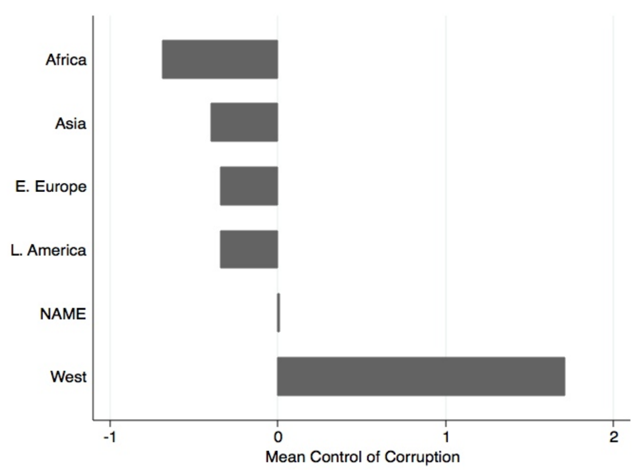

Figure 10: Mean Control of Corruption by Region

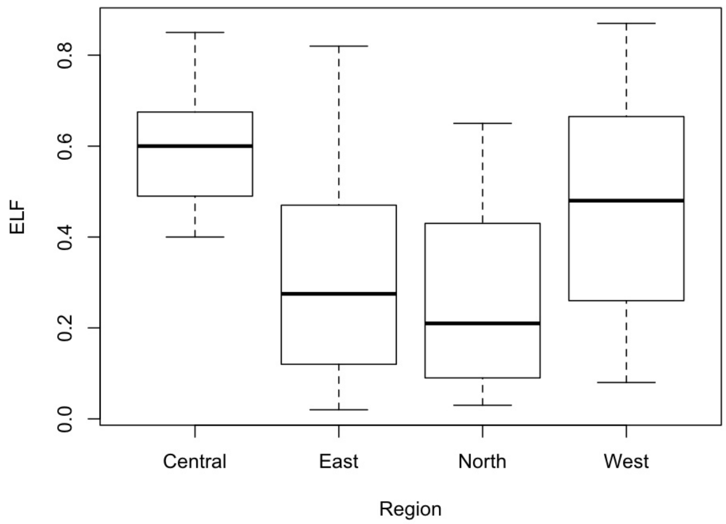

Figure 11: Ethnic Diversity by Region in Uganda

Table 10: Ethnic Diversity and Infant Mortality by Income Level

	All	Low	Lower-Middle	Upper-Middle	High
(Intercept)	7.80***	5.54***	8.03***	10.18**	7.84*
	(0.47)	(0.86)	(1.77)	(3.14)	(3.43)
ELF	0.92***	0.68**	1.11**	0.51	0.94*
	(0.18)	(0.23)	(0.39)	(0.44)	(0.42)
GDPpc	−0.55***	−0.29**	−0.55**	−0.75*	−0.56†
	(0.05)	(0.10)	(0.20)	(0.31)	(0.33)
Avg. Polity	−0.03***	0.01	−0.04**	−0.04*	−0.05**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Malaria	0.39**	0.33	0.09	0.84*	0.04
	(0.15)	(0.23)	(0.26)	(0.41)	(0.67)
N	152	44	36	31	33
R^2	0.82	0.39	0.51	0.53	0.40
adj. R^2	0.81	0.33	0.45	0.46	0.31
Resid. sd	0.51	0.39	0.46	0.52	0.47

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 11: Ethnic Diversity and Health Outcomes No Africa, Basic Model

	IMR	Under-5	MMR	TFR	Life	Expend.	Healthpc	Change	Immune	DALY	Birth	Sanit.
(Intercept)	7.68***	8.15***	9.32***	5.46***	38.75***	0.46	−5.13***	−0.05	62.82***	11.87***	−41.65	−13.90
	(0.83)	(0.80)	(1.21)	(1.46)	(7.02)	(1.59)	(1.15)	(0.04)	(12.18)	(0.45)	(35.96)	(30.81)
ELF	0.97***	0.94***	0.96**	0.56	−5.13**	−1.12*	−0.41†	0.01	−0.57	0.23*	0.67	0.56
	(0.22)	(0.23)	(0.31)	(0.34)	(1.70)	(0.56)	(0.23)	(0.01)	(4.52)	(0.09)	(11.62)	(8.50)
GDPpc	−0.56***	−0.62***	−0.61***	−0.38**	3.66***	0.16	1.08***	0.00	3.21**	−0.23***	14.14***	9.98**
	(0.08)	(0.08)	(0.11)	(0.14)	(0.67)	(0.17)	(0.10)	(0.00)	(1.22)	(0.04)	(3.47)	(2.98)
Avg. Polity	−0.04**	−0.03*	−0.02	−0.03*	0.15*	0.06*	0.04***	0.00	0.05	−0.01	0.01	−0.27
	(0.01)	(0.01)	(0.01)	(0.01)	(0.07)	(0.03)	(0.01)	(0.00)	(0.20)	(0.00)	(0.36)	(0.33)
Malaria	0.16	0.19	0.51	0.66†	−0.56	−0.19	−0.06	−0.00	−6.67	0.10	−20.28*	−14.04
	(0.23)	(0.23)	(0.34)	(0.34)	(1.84)	(0.54)	(0.24)	(0.01)	(5.63)	(0.12)	(9.89)	(8.77)
E. Europe	0.02	0.14	−0.77**	0.00	−0.96	1.26**	0.45*	0.00	1.69	0.11	9.33	17.87*
	(0.22)	(0.21)	(0.27)	(0.25)	(1.43)	(0.46)	(0.22)	(0.01)	(4.16)	(0.09)	(10.18)	(6.86)
L. America	0.50*	0.47*	0.16	0.58*	0.26	0.99†	0.46*	0.00	−3.81	0.01	6.90	10.65
	(0.21)	(0.21)	(0.25)	(0.24)	(1.37)	(0.52)	(0.20)	(0.01)	(4.66)	(0.08)	(10.35)	(7.22)
NAME	0.19	0.15	−0.22	0.74*	0.88	0.75	0.66**	−0.03**	−0.91	−0.10	10.59	11.05†
	(0.23)	(0.24)	(0.27)	(0.32)	(1.43)	(0.45)	(0.23)	(0.01)	(4.23)	(0.11)	(9.60)	(6.62)
West	−0.16	−0.04	−0.87**	0.63**	1.83	3.76***	1.46***	0.02†	−3.30	−0.02	−6.45	15.09†
	(0.23)	(0.24)	(0.27)	(0.23)	(1.41)	(0.47)	(0.21)	(0.01)	(4.38)	(0.09)	(11.19)	(7.60)
N	109	109	109	109	109	109	107	109	107	108	71	87
R^2	0.81	0.80	0.84	0.56	0.75	0.70	0.94	0.37	0.21	0.68	0.66	0.68
adj. R^2	0.80	0.79	0.82	0.52	0.73	0.68	0.94	0.32	0.15	0.66	0.61	0.65
Resid. sd	0.45	0.45	0.53	0.59	3.23	1.17	0.41	0.02	10.12	0.21	14.66	12.79

Robust standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 12: PREG and Health Outcomes No Africa, Full Model

	IMR	Under-5	MMR	TFR	Life	Expend.	Healthpc	Change	Immune	DALY	Birth	Sanit.
(Intercept)	3.50**	3.85***	6.23**	6.08†	73.82**	−1.39	2.12	−0.05	98.10	11.08***	−3.01	−6.75
	(1.06)	(0.93)	(1.86)	(3.04)	(19.10)	(5.01)	(2.16)	(0.06)	(59.44)	(1.10)	(51.02)	(74.21)
PREG	−0.51†	−0.64**	−0.18	0.21	12.24*	−0.20	0.26	0.01	−19.41	−0.12	−10.28	8.76
	(0.25)	(0.22)	(0.44)	(0.72)	(4.50)	(1.18)	(0.51)	(0.01)	(14.00)	(0.26)	(13.06)	(17.48)
GDPpc	−0.00	−0.02	−0.10	−0.36	−0.21	−0.35	0.43*	0.00	−4.72	−0.12	9.40†	2.75
	(0.09)	(0.08)	(0.15)	(0.25)	(1.58)	(0.41)	(0.18)	(0.00)	(4.91)	(0.09)	(4.47)	(6.13)
Avg. Polity	0.00	−0.00	0.03	−0.02	−0.14	0.06	−0.02	0.00**	−0.87	0.01	0.31	0.49
	(0.01)	(0.01)	(0.02)	(0.03)	(0.20)	(0.05)	(0.02)	(0.00)	(0.62)	(0.01)	(0.54)	(0.78)
Malaria	0.60*	0.57*	0.63	1.15	−5.25	3.00*	0.07	0.01	4.65	0.32	22.63	−2.31
	(0.26)	(0.23)	(0.46)	(0.75)	(4.74)	(1.24)	(0.54)	(0.01)	(14.77)	(0.27)	(13.95)	(18.44)
Education	−0.00	−0.00	−0.01	−0.01	−0.03	0.01	−0.00	−0.00†	0.49*	−0.00	0.00	0.09
	(0.00)	(0.00)	(0.01)	(0.01)	(0.07)	(0.02)	(0.01)	(0.00)	(0.20)	(0.00)	(0.19)	(0.26)
Corruption	−0.52*	−0.41*	−0.65†	0.35	7.71*	0.74	0.95*	−0.02†	7.89	−0.18	5.95	−6.78
	(0.18)	(0.16)	(0.32)	(0.53)	(3.30)	(0.87)	(0.37)	(0.01)	(10.29)	(0.19)	(9.39)	(12.84)
Roads	−0.00	−0.01**	−0.01†	−0.02*	0.02	0.03†	0.00	−0.00	0.27	−0.00	0.34*	0.51*
	(0.00)	(0.00)	(0.01)	(0.01)	(0.05)	(0.01)	(0.01)	(0.00)	(0.16)	(0.00)	(0.14)	(0.21)
Rural	0.00	0.01*	−0.00	0.03*	−0.13†	0.03†	−0.02†	−0.00*	0.01	0.00	−0.63**	−0.22
	(0.00)	(0.00)	(0.01)	(0.01)	(0.07)	(0.02)	(0.01)	(0.00)	(0.21)	(0.00)	(0.18)	(0.27)
HIV	0.01	0.01	0.07**	−0.04	−0.45*	0.18**	0.03	0.00***	−0.03	0.02†	1.22*	1.00
	(0.01)	(0.01)	(0.02)	(0.03)	(0.20)	(0.05)	(0.02)	(0.00)	(0.62)	(0.01)	(0.53)	(0.78)
N	29	29	29	29	29	29	29	29	29	29	26	29
R^2	0.79	0.88	0.78	0.79	0.67	0.64	0.82	0.86	0.60	0.60	0.78	0.50
adj. R^2	0.70	0.82	0.67	0.69	0.51	0.47	0.73	0.79	0.40	0.42	0.66	0.26
Resid. sd	0.23	0.20	0.41	0.66	4.18	1.10	0.47	0.01	13.00	0.24	10.63	16.22

Standard errors in parentheses

† significant at $p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$