Land Use and Infant Mortality: Evidence from Africa[1]
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Abstract
This study investigates the relationship between agricultural land use (share of arable land area) and infant mortality (deaths less than one year of age) in nineteen African countries from 1990 to 2012. Data have been collected from the World Bank. This research contributes to the existing literature by (1) including nineteen African countries, (2) using data for the last thirteen years, and (3) taking into consideration both linear and cubic models for country and time interactions to better understand the association between land use and infant mortality across all countries over time. In all models, we include country and year fixed effects variables and country and time interactions. Our covariates include (i) GDP per capita, (ii) immunizations for measles, (iii) total fertility rate, (iv) female labor force participation, (v) HIV prevalence, (vi) undernourishment rate, (vii) anemia prevalence among pregnant women, and (viii) food production index. Our findings suggest that an increase in land use is predicted to reduce infant mortality; our results are significant throughout all model specifications**.** After discussing several important research challenges, we conclude with policy implications that may help increase land productivity and reduce infant mortality in African countries.

Running Head
Land use and infant mortality

Keywords
Africa, land, agriculture, infant mortality, health, development

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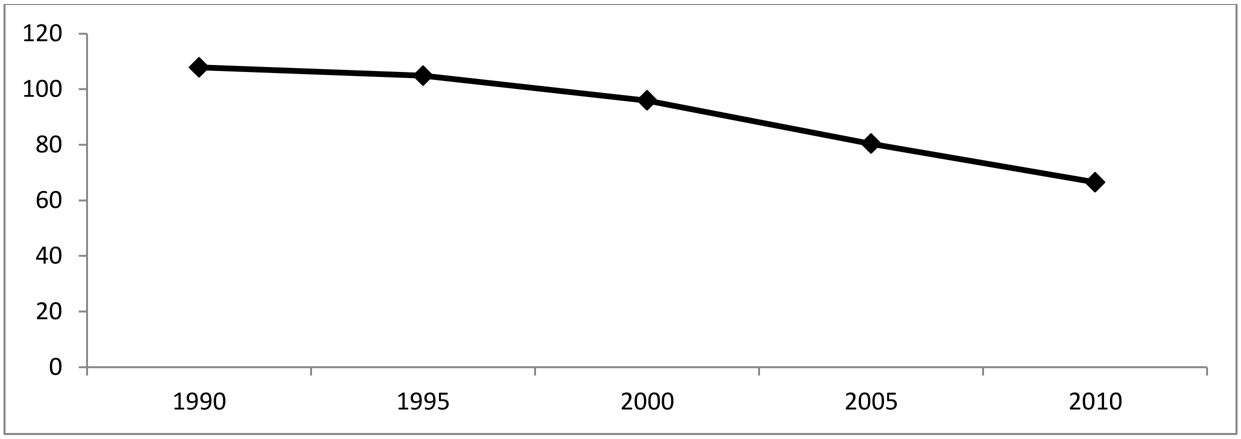
Introduction

This study investigates the relationship between agricultural land use (share of arable land area) and infant mortality (deaths less than one year of age) in nineteen African countries from 1990 to 2012; the nineteen countries are Angola, Burkina Faso, Burundi, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leon, Tanzania, Uganda, and Zambia. While there have been a great deal of advances in health, social, and economic development that have taken place in many African countries over the last decades, little scholarly attention has been paid to the specific effects of arable land use on the wellbeing of families and communities in this fast-growing continent.

Figure 1 presents the change/decline in infant mortality in nineteen African countries from 1990 to 2012. Figure 2 shows the change/increase in arable land use. While there are many factors, at both macro and micro level levels, which are known to have positive effects on infant wellbeing, this study estimates the role of arable land use. We intend to contribute to the existing empirical literature by (1) including nineteen African countries, (2) using data for the last thirteen years, and (3) incorporating both linear (for country and time trend interactions) and cubic models to better understand the association between land use and infant mortality in all nineteen countries for the last thirteen years.

Figure 1: Infant mortality in nineteen African countries, 1990-2010



Data Source: World Bank.
Numbers are scaled per 1,000 live births.

Theory and Previous Research

A review of the literature reveals little to no discussion of the effects of land use on infant mortality or other measures of health or public health. We find this surprising, given the nature of agriculture production in the developing world and the known effects of nutrition and food security on health and infant and maternal health in particular. The literature shows mixed findings concerning the direct relationship between economic growth and reductions in infant mortality. For instance, Ferrarini and Norström (2010) indicated that while economic growth decreased infant mortality in the earlier part of the 20th century, the postwar period showed a zero or even a reversed correlation between economic development and child health in OECD countries. Pamuk et al. (2011), on the other hand, found significant effects of both per capita Gross National Income (GNI) and secondary education completion at the country level on infant mortality in the underdeveloped world.

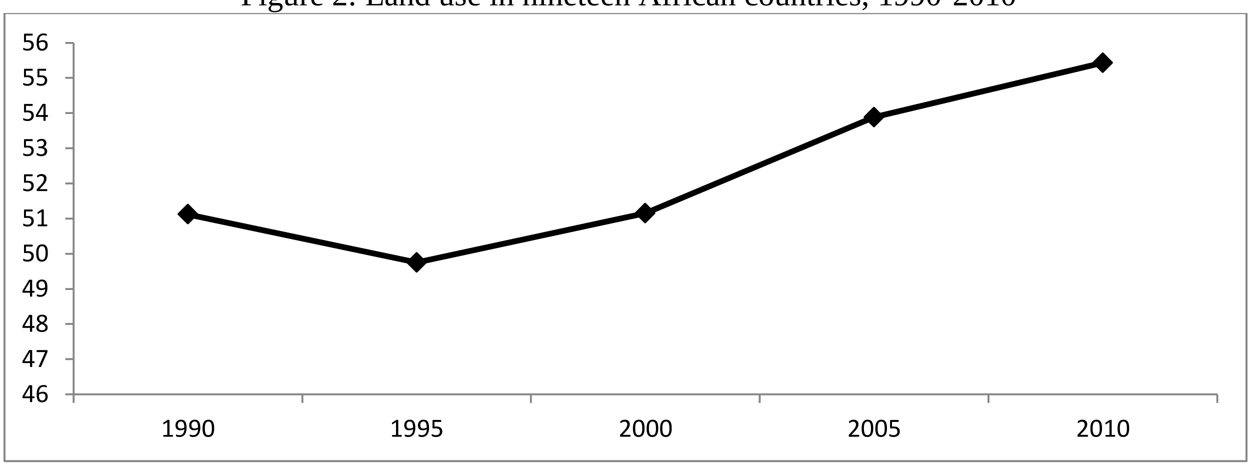
Direct cash transfers do reduce infant mortality in both OECD nations (Almond et al., 2011) and the developing world (Barnham, 2011; Rasella et al., 2013). Non-economic factors like water and sanitation access, indices of gender inequity, health infrastructure variables, changes in fertility patterns, and government programs like WIC (special supplemental nutrition program for women, infants, and children) in the US that directly support mothers and infants have been shown to have important roles in reducing infant mortality (Agha, 2000; Almond et al., 2011; Flegg, 1982; Morton-Ntenda et al., 2014; Trusell & Pebley, 1984). Economic crises such as droughts and famines are also important predictors of changes in infant mortality rates (Christian, 2010). Interestingly, there is some evidence that indicates much of the gains in reducing infant mortality rates, at least in sub-Saharan Africa, may be ethereal and not sustainable. Akachi and Canning (2010) find a reduced infant mortality but no concurrent improvement in measures of health status among older children or adults. This perhaps indicates that the progress in infant mortality is largely due to policy and programmatic interventions on specific aspects of perhaps isolated factors mentioned above and that these interventions do not reduce the impact of more fundamental causes of infant mortality in the developing world.

We believe that the relationship between land usage and infant mortality is important to explore. The needs to produce food, have a stable source of wealth, and generate income are often satisfied in the developing world through agricultural activities. How the productive asset of land is utilized and distributed is likely to have effects on a whole host of health, public health, and social welfare indicators in nations in the developing world. It is beyond the scope of this project to examine the effects of land distribution on infant mortality, but we do think it is a worthwhile endeavor to understand how the percentage of land used for agriculture affects the health status and life chances of the most vulnerable members of any society.

Our model assumes land is a productive asset of particular importance in developing nations. When that asset is used for activities that promote food security, generate incomes and encourage economic stability, it is likely to improve infant mortality and other health indicators that are at least partially influenced by income and economic stability. Our hypothesis, therefore, is that the more land is used for agriculture in the largely agricultural economies of the developing world; the lower the infant mortality rate is in those nations.

There are clear limitations to this model. We are viewing land use independent of distribution, technological inputs, and the type of agricultural product (export commodities or edible goods) produced. We also recognize the ecological and fertility challenges associated with farming on increasingly marginal land. This is an exploratory study that seeks to establish a baseline for discussing the aforementioned issues and their relationship to the issue of infant mortality. We believe that without understanding the baseline relationship between land use and infant mortality, we cannot begin to explore more complex questions about relationships between land tenure, production technology, and types of agriculture product and infant mortality.

Figure 2: Land use in nineteen African countries, 1990-2010



Data Source: World Bank.
Numbers refer to the share of land area that is arable, under permanent crops, and under permanent pastures.

Data: Measures and Method of Analyses

In this paper, we estimate the effects of arable land use on infant mortality in nineteen African countries from 1990 to 2012, using Generalized Linear Models (GLMs). Table 1 provides the descriptive statistics for all of the variables used in our study. The data were all retrieved from World Bank.[2]

Table 1. Summary of variables used in this analysis

	N	Mean	S.D.
Infant mortality	437	89.45	26.23
Arable land use	418	52.21	18.50
GDP per capita	437	1726.65	1154.72
Immunization for measles	437	67.37	21.00
Total fertility rate	437	5.92	0.93
Female labor force participation	437	70.28	14.77
HIV prevalence	437	5.48	5.36
Undernourished prevalence	415	32.49	14.97
Anemia among pregnant women	418	50.44	10.90
Food Production	434	90.69	27.82

Data Source: World Bank.

- **Agricultural land** (independent variable): Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures.[3] All values are continuous.

[2] Original data sources include the United Nations Inter-agency Group for Child Mortality Estimation (www.childmortality.org), United Nations Children's Fund, Joint United Nations Programme on HIV/AIDS, Food and Agriculture Organization, World Health Organization, International Labor Organization, United Nations Population Division, United Nations Statistical Division, as well as Census reports and other statistical publications from national statistical offices.

[3] Arable land includes land defined by the Food and Agriculture Organization (FAO) as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops (World Bank).

- **Infant mortality** (outcome variable): Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year. All values are continuous and in the natural log (non-zero positively skewed).

In all models, we included country fixed effects, year fixed effects, and country-time trend interactions to control for unobserved factors across nineteen countries and time periods from 1990 to 2012: (1) Country fixed effects are incorporated in order to control for the specific fixed effects of each country over a time period; (2) Year fixed effects in order to control for the specific fixed effects of each year for all countries; and (3) Country-time trend interactions to control for country-specific time varying effects—i.e., whether the effects of the country on the outcome depend on time, as well as whether the change of outcome with time depends on the particular country. For the country-time interaction variables, we first tested for linear trends and compared the results to those of cubic models to see whether the time trend variations contribute to the effects of land use on the outcome.

We analyzed the effects of arable land use on infant mortality including various control variables that can be closely related to the association between our independent and outcome variables (all variables are continuous):

(1) Real GDP per capita in thousands of purchasing power parity (PPP)-adjusted in the 2011 international dollars. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States;
(2) Percent of immunization for measles for children under one year of age;
(3) Total fertility rate as 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;
(4) Female labor force participation rate as the percentage of female population ages 15-64 that is economically active (defined by the International Labour Organization);
(5) Prevalence of HIV as the percentage of people ages 15-49 who are infected with HIV;
(6) Prevalence of undernourishment (also referred to as population below minimum level of dietary energy consumption) as the percentage of the population whose food intake is insufficient to meet dietary energy requirements continuously;
(7) Prevalence of anemia among pregnant women as the percentage of pregnant women whose hemoglobin level is less than 110 grams per liter at sea level; and

(8) Food production index which covers food crops that are considered edible and that contain nutrients. Food production per capita index presents net food production (after deduction for feed and seed) of a country's agricultural sector per person relative to the base period 2004-2006**.** While edible, food with no nutritive value, such as coffee and tea are excluded (World Bank).

GDP per capita is a universally used economic indicator for a country's wealth, which may influence child wellbeing. As noted above, while some studies suggested that the direct effects of GDP per capita on infant mortality can be questionable (Ruhm, 2004; Tapia Granados, 2005), others pointed out its positive effects in decreasing infant mortality (Ferrarini & Sjoberg, 2010; Pritchett & Summers, 1996). Immunizations for measles can also be important protective factors for a newborn, which may predict other child health outcomes (McCormick, 1985; Strully et al., 2010). Fertility rates are included because they are likely related to the number of deaths among newborns; moreover, female labor force participation is taken into consideration because it can positively impact child wellbeing with an income, yet at the same time, it can prevent mothers from spending more time taking care of their infants (Tanaka, 2005). Additional variables that are closely related to infant mortality are included, wherever data were available. For instance, factors such as HIV prevalence, undernourishment rate, as well as anemia prevalence among pregnant women are also added. Finally, we considered the Food Production Index as an additional control variable since it represents the overall agricultural productivity, which may have multiple implications (as a proxy) for a country's technology (machinery, fertilizer, training, etc.), infrastructure (water system, etc.), and even weather.

Results and Conclusion

The results overall indicate that an increase in arable land use is significantly associated with reductions in infant mortality. In Table 2, in Model 1 without any control variables (all of our analyses include time and country fixed effects as well as country and time trend interactions), the results indicate that a ten-percent increase in the share of arable land is predicted to reduce infant mortality by 11% (p=0.000) An 11% decrease in infant mortality means a reduction in the infant death rate from 10 to 8.9 per 1,000 live births. In Models 2 and 3 with GDP per capita and immunization for measles, the results are the same and significant, indicating that a ten-percent increase in the share of arable land is predicted to reduce infant mortality by 11% (p=0.003). Furthermore, the results indicate that although on a small scale, a ten-percent increase in immunization for measles has significant effects on reducing infant mortality by 1% (p=0.003).

In Model 4 with additional variables related to family and labor market dynamics, which can influence child wellbeing (fertility rates and female labor force participation), the results indicate that a ten-percent increase in the share of arable land is predicted to reduce infant mortality by slightly reduced effects, 10% (p=0.000). Both fertility rate and female labor force participation have a negative association with infant mortality (p=0.001 and p=0.000, respectively). Finally, Model 5 with an additional health indicator, HIV prevalence, shows the same results as Model 4: a 10% reduction of infant mortality (p=0.000). While factors such as HIV prevalence, among infants under specifically age one, would be also informative, such data were not available.

Table 2. Effects of land use on log of infant mortality in nineteen African countries, 1980-2012

Infant Mortality					
Regressor	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Arable land use	**-0.011** (0.001)**	**-0.011** (0.001)**	**-0.011** (0.001)**	**-0.010** (0.001)**	**-0.010** (0.001)**
GDP per capita		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Immunization for measles			-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
Total fertility rate				-0.087** (0.027)	-0.094** (0.027)

Female labor force participation				-0.011** (0.002)	-0.011** (0.002)
HIV prevalence					-0.001 (0.002)
N	*396*	*396*	*396*	*396*	*396*
R^2	*0.98*	*0.98*	*0.98*	*0.98*	*0.98*
Country FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Year FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Country-Time (linear)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

**p<0.05, **p<0.01*

Note: Numbers shown are coefficients (with standard errors in parentheses).

With nutrition-related control variables, Table 3 presents results that suggest the positive effects of land use on reducing infant mortality. In both Models 1 (undernourishment rate added) and 2 (undernourishment rate and anemia among pregnant women added), the results were the same and significant, indicating that a ten-percent increase in the share of arable land is predicted to reduce infant mortality by 8% (p=0.000), slightly reduced effects compared to previous findings. The reduced effects may be due to the fact that we added more variables in our models, which use up some of the sum of squares in general; however, the results are consistent in that there are positive effects of increased land use on reducing infant mortality. Also in both models, the prevalence of undernourishment was positively associated with infant mortality: a 4% reduction in infant mortality (p=0.000); however, anemia among pregnant did not show any effects on infant deaths.

In Model 3 with food production, the results indicate that a ten-percent increase in the share of arable land is predicted to reduce infant mortality by 9% (p=0.000). The prevalence of undernourishment again had a strong positive association with infant mortality; a ten-percent increase in undernourishment rate has significant effects on increasing infant mortality by 5% (p=0.000). On the other hand, both anemia among pregnant women and food production did not have any significant effects on infant mortality. Finally, Model 4 takes into consideration cubic time trends (for interactions for country and time); the results still indicate that there are positive effects of land use on reducing infant mortality, and the effects are the same. A ten-percent increase in the share of arable land is predicted to reduce infant mortality by 9% (p=0.000). In conclusion, this research examines and confirms the positive effects of increased arable land use on reducing infant mortality in nineteen African countries from 1990 to 2012. While the effect sizes slightly vary across different model specifications, the overall implications are consistent.

Table 3. Effects of land use on log of infant mortality in nineteen African countries, 1980-2012, Including additional nutrition-related control variables

	Infant Mortality			
Regressor	*Model 1*	*Model 2*	*Model 3*	*Model 4*
Arable land use	**-0.008** **(0.001)**	**-0.008** **(0.001)**	**-0.009** **(0.001)**	**-0.009** **(0.001)**
GDP per capita	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Immunization for measles	-0.002** (0.000)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
Total fertility rate	-0.083** (0.025)	-0.094** (0.027)	-0.087** (0.027)	-0.087** (0.027)
Female labor force participation	-0.009** (0.002)	-0.008** (0.002)	-0.009** (0.002)	-0.009** (0.002)
HIV prevalence	-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)
Undernourished prevalence	0.004** (0.001)	0.004** (0.001)	0.005** (0.001)	0.005** (0.001)
Anemia among pregnant women		0.003 (0.003)	0.003 (0.003)	0.003 (0.003)
Food production			0.000 (0.000)	0.000 (0.000)
N	*396*	*396*	*396*	*396*
R^2	*0.98*	*0.99*	*0.99*	*0.99*
Country FE	*Yes*	*Yes*	*Yes*	*Yes*
Year FE	*Yes*	*Yes*	*Yes*	*Yes*
Country-Time (linear)	*Yes*	*Yes*	*Yes*	*Yes^*

**p<0.05, **p<0.01*

^Cubic time trends are used in Model 4.

Note: Numbers shown are coefficients (with standard errors in parentheses).

Research Challenges and Policy Implications

There are more variables to be included that influence infant wellbeing including early mortality rates. For instance, an expectant mothers' smoking and drinking can result in higher rates of early mortality rates and low birth weight (Chomitz et al., 1995; Difranza et al., 2004; Frisbie et al., 1996; Lightwood et al., 1999). It is also reported that physically demanding work conditions for expecting mothers (e.g., long working hours and prolonged standing) can result in negative birth outcomes (Mozurkewich et al., 2000). Prenatal care (e.g., receiving advice on vitamin use and proper weight gain) as well as neonatal care in the early days of a newborn's life are other factors that may influence infant mortality (Currie & Gruber, 1997; Kogan et al., 1994). Furthermore, breastfeeding greatly benefits child health (Chen & Rogan, 2004; Lawrence, 1997). As mentioned previously, the prevalence of HIV/AIDS among children under age one would also be an important variable to include in this research. However, sufficient data on these indicators are not available.

In addition, it is important to discuss how unexpected life-threatening events, both natural and man-made, such as epidemics/diseases, droughts/floods, civil wars, and genocides impact infant wellbeing in African countries over the last thirteen years. For example, in 2011, a lack of rain in East African countries, including Kenya and Ethiopia, led to the crop failure and livestock depletion which increased prices of goods (Stigter & Ofori, 2014). Man-made water pollution due to overcrowding and poor drainage and sewage disposal systems also threatens the livelihood of many families and children in East Africa (United Nations Environment Programme [UNEP], 1998); for instance, eighty-eight percent of diarrheal disease in developing countries is attributed to a lack of access to safe drinking water (World Health Organization [WHO], 2004). In 1994, during the Rwandan Genocide, more than sixty-seven percent of women who were raped were infected with HIV and AIDS; often times survivors of rape passed the infection on to their children (Amnesty International, 2004). To address the issue of cross-country and -time variations, we incorporated fixed effects and country-time interactions and will continue to explore better ways for analysis.

Despite some of the challenges mentioned, our study provides important policy implications. Our findings indicate that an increased land use overall has positive effects on reducing infant mortality. Therefore, if our goal is to reduce infant mortality in African countries, among many social, economic, and political factors, we should also perhaps consider how to increase land use and possibly boost its arable productivity in both short and long runs. Agriculture-related investment in families and communities via education, training, and basic provision for resources to farm and harvest, is also urgently needed.

The challenge of climate change makes the results of this study even more compelling. Our finding that land use is related to infant mortality rates become especially important in light of climate change and its effects on land fertility and land use. The option of simply opening more land to agricultural use in response to our findings is less and less realistic in an era of climate change and ecological decay. As farming on more and more marginal lands becomes even less of an ideal solution to issues of land use, questions of tenancy and technological inputs become even more important as policy issues. We find that land use does affect infant mortality, and since climate change and other ecological and environmental issues constrain states from simply opening more land to agricultural production, our findings should motivate states, international agencies, and donors to explore more creative responses.

References

Agha, S. (2000). The determinants of infant mortality in Pakistan. *Social Science & Medicine, 51*(2), 199-208.

Akachi, Y., & Canning, D. (2010). Health trends in Sub-Saharan Africa: conflicting evidence from infant mortality rates and adult heights. *Economics & Human Biology, 8*(2), 273-288.

Almond, D., Hoynes, H.W., & Schanzenbach, D.W. (2011). Inside the War on Poverty: The Impact of Food Stamps on Birth Outcomes. *The Review of Economics and Statistics, 93*(2), 387-403.

Amnesty International (2004). *Rwanda: "Marked for Death", rape survivors living with HIV/AIDS in Rwanda.* AFR 47/007/2004. New York: AI. Available at http://www.amnesty.org/en/library/asset/AFR47/007/2004/en/53d74ceb-d5f7-11dd-bb24-1fb85fe8fa05/afr470072004en.pdf. Accessed September, 2014. Accessed September, 2014.

Barnham, T. (2011). A healthier start: The effect of conditional cash transfers on neonatal and infant mortality in rural Mexico. *Journal of Development Economics, 94*(1), 74–85.

Chen, A., & Rogan, W.J. (2004). Breastfeeding and the risk of post-neonatal death in the United States. *Pediatrics, 113*(5), e435-e439.

Chomitz, V.R., Cheung, L.W.Y., & Lieberman, E. (1995). The role of lifestyle in preventing low birth weight. *The Future of Children, 5*(1), 121-138.

Christian, P. (2010). Impact of the economic crisis and increase in food prices on child mortality: exploring nutritional pathways. *The Journal of nutrition, 140*(1), 177S-181S.

Currie, J & Gruber, J. (1997). Saving babies: The efficacy and cost of recent changes in the Medicaid eligibility of pregnant women. *Journal of Political Economy, 104*(6), 1263-1296.

DiFranza, J.R., Aligne, C.A., & Weitzman, M. (2004). Prenatal and postnatal environmental tobacco smoke exposure and children's health. *Pediatrics, 113*(3), 1007-1015.

Ferrarini, T., & Norström, T. (2010). Family policy, economic development and infant mortality: a longitudinal comparative analysis. *International Journal of Social Welfare, 19*(s1), S89-S102.

Flegg, A. T. (1982). Inequality of income, illiteracy and medical care as determinants of infant mortality in underdeveloped countries. *Population studies, 36*(3), 441-458.

Frisbie, R.G., Strobino, D.M., Salkever, D.S., & Jackson, C.A. (1996). Updates estimates of the impact of prenatal care on birth weight outcomes by race. *Journal of Human Resources, 27*(4), 629-642.

Kogan, M.D., Alexander, G.R, Kotelchuek, M., & Nagey, D.A. (1994). Relation of the content of prenatal care to the risk of low birth weight: Maternal reports of health behavior advice and initial prenatal care procedures. *Obstetrical & Gynecological Survey*, *49*(10), 667-668.

Lawrence, R. A. (1997). *A review of the medical benefits and contraindications to breastfeeding in the United States.* Arlington, VA: National Center for Education in Maternal and Child Health.

Lightwood, J.M., Phibbs, C.S., & Glantz, S.A. (1999). Short-term Health and Economic Benefits of Smoking Cessation: Low Birth Weight. *Pediatrics, 104*(6), 1312-1320.

McCormick, M. C. (1985). The contribution of low birth weight to infant mortality and childhood morbidity. *New England Journal of Medicine*, 312(2), 82-90.

Morton-Ntenda, P. A. M., Chuang, K. Y., Tiruneh, F. N., & Chuang, Y. C. (2014). Factors Associated with Infant Mortality in Malawi. *Journal of Experimental & Clinical Medicine*, *6*(4), 125-131.

Mozurkewich, E.L., Luke, B., Avni, Michal, & Wolf, F.M. (2000). Working conditions and adverse pregnancy outcome: A Meta-analysis. *Obstetrics & Gynecology, 95*(4), 623-635.

Pamuk, E. R., Fuchs, R., & Lutz, W. (2011). Comparing relative effects of education and economic resources on infant mortality in developing countries. *Population and development review*, *37*(4), 637-664.

Pritchett, L., & Summers, L.H. (1996). Wealthier is healthier. *Journal of Human Resources, 31,* 841–868.

Rasella, D., Aquino, R., Santos, C. A., Paes-Sousa, R., & Barreto, M. L. (2013). Effect of a conditional cash transfer programme on childhood mortality: A nationwide analysis of Brazilian municipalities. *The lancet*, *382*(9886), 57-64.

Ruhm, C. (2000). Parental leave and child health. *Journal of health economics*, *19*(6), 931-960.

Ruhm, C. (2004). Parental employment and child cognitive development. *Journal of Human Resources*, *39*(1), 155-192.

Stigter, C. J., & Ofori, E. (2014). What climate change means for farmers in Africa: A triptych review left panel: Increasing climate variabilty and a response approach for African farmers. *African Journal of Food, Agriculture, Nutrition and Development*, *14*(1), 8445-8458.

Strully, K., Rehkopf, D., & Xuan, Z. (2010). Effects of prenatal poverty in infant health: State earned income tax credits and birth weight. *American Sociological Review, 75*(4), 534-562.

Tanaka, S. (2005). Parental leave and child health across OECD countries. *Economic Journal, 115*, F7-F28.

Tapia Granados, J.A. (2005). Increasing mortality during the expansions of the US economy, 1900–1996. *International Journal of Epidemiology*. *34*, 1194–1202

Trussell, J., & Pebley, A. R. (1984). The potential impact of changes in fertility on infant, child and maternal mortality. *Studies in family Planning*, 267-280.

United Nations Environment Programme [UNEP]. (1998). *Freshwater Environment in the Eastern African Region.* UNEP Regional Seas Reports and Studies No. 167. UNEP/ Institute of Marine Sciences, University of Dar es Salaam/FAO/SIDA.

World Health Organization. (2004). *Water, sanitation and hygiene links to health, facts and figures*. Geneva: WHO. Available at http://www.who.int/water_sanitation_health/en/factsfigures04.pdf?ua=1. Accessed September, 2014.

World Bank, World Development Indicators. Available at http://databank.worldbank.org/data/home.aspx. Accessed August , 2014.