# Inequitable health outcomes following the introduction of antiretroviral therapy in Addis Ababa, Ethiopia


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## Introduction

The large-scale provision of anti-retroviral therapy (ART) is currently one of the most important public health interventions in eastern and southeastern Africa. An inadvertent consequence of the rollout of ART may be the intensification of health inequities. This is of particular concern for the early phase of an ART rollout when medication can be scarce, often rationed, and only available under a co-pay scheme. Unlike most previous efforts, which were largely based on cohorts of clinic patients, we use a population perspective to investigate the possible relationship between the rollout of ART and health equity.

## Background

***Addis Ababa, Ethiopia:*** With nearly three million inhabitants, Addis Ababa is one of the largest urban centers in East Africa. At the time of our study it was administratively classified into 328 kebeles. Kebeles in the 1994 census ranged in population from 500 to over 20,000 inhabitants. The Ethiopian Ministry of Health estimated urban HIV prevalence in 2003 at 12.6% (MOH 2004), and it is estimated that 60% to 70% of adult deaths (aged 20- 54) occurring in the year 2001 are attributable to AIDS (Araya et al. 2004; Reniers, Araya and Sanders 2006a).

***ART Rollout:*** Since 1999, a limited number of AIDS patients have been receiving antiretroviral medication through the informal market and usually at a very high cost. In July 2003, the Ethiopian government adopted a policy to provide ART through a co-pay scheme whereby the contribution from patients ranged from USD30 to USD80 per month, depending on the combination of drugs. By February 2005, the government had launched a free ART program in which new patients are enrolled as well as transferred from the fee-based schemes. In this analysis, the period between February 2001 and July 2003 precedes and the period between August 2003 and December 2005 is subsequent to the rollout of ART.

## Research Questions

- **Is AIDS mortality inversely correlated with socioeconomic status?**
- **Does the relationship between socioeconomic status, specifically wealth and education, and AIDS mortality change after the introduction of anti-retroviral therapy?**

## Data

Mortality data comes from the Addis Ababa Mortality Surveillance Project, which was initiated at all cemeteries of Addis Ababa in February, 2001. Currently over 80 cemeteries are under surveillance and that includes more than 50 Orthodox Christian churchyards, several Muslim and municipal cemeteries as well as a few cemeteries for other religions. In all cemeteries combined, over 20,000 deaths are recorded annually and the coverage is estimated between 80% and 90% (Reniers et al. 2006). Summary measures for socio-economic status (wealth and educational attainment) and other background characteristics are taken from the 1994 census which is aggregated at the kebele level (CSA 1995).

## Methods

The data used in this analysis links burial surveillance records to census geography (kebeles), which is the unit for all analysis. As the geography is used for purposes of enumerating the census and has no analytic justification in terms of AIDS mortality, neighboring kebeles are not independent in terms of the variable of interest, which residual analysis testing for the presence of spatial autocorrelation confirm (Moran's I=0.27, p≤0.001). The spatial lag model was selected to appropriately incorporate the spatial structure of Addis Ababa into the modeling process.

## Model

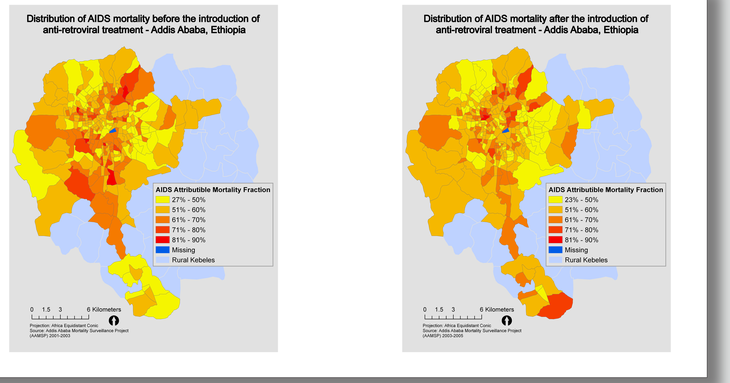
The spatial lag model considers the spatial dependency to be a component of the outcome of interest. In this case, we use a boundary share weight matrix ($W_{ij}$), which models the spatial structure of Addis Ababa as the proportion of a kebele's boundary ($l_i$) that is shared by a neighboring kebele ($l_{ij}$), to explicitly model the measured spatial autocorrelation. The outcome (y), which is the fraction of mortality attributable to AIDS (AAMF), is modeled as a function of SES as well as other characteristics of the kebele.

$$y = \lambda W_{ij} y + X\beta + \varepsilon$$

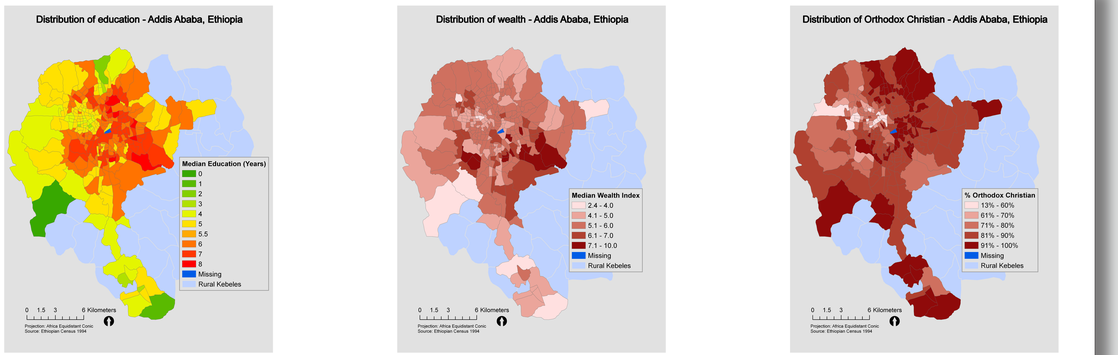
$$\varepsilon \sim N(0, \sigma^2)$$

$$W_{ij} = \begin{cases} \frac{l_{ij}}{l_i}, & l_i > 0 \\ 0, & otherwise \end{cases}$$

## Dependent Variable




## Independent Variables




## Results

Spatial lag regression of education, wealth, and religion on the proportion of mortality attributable to AIDS (AAMF) - Addis Ababa, Ethiopia*

| | Model 1 | | Model 2 | | Model 3 | | |
|---|---|---|---|---|---|---|---|
| | β | (z) | β | (z) | β | (z) | |
| Education (1=6+ years) | -0.56 | (-0.79) | 0.81 | (0.80) | 2.32 | (2.18) | * |
| Time Period (1=post-ART) | | | 0.64 | (0.60) | 0.62 | (0.61) | |
| Wealth Index | | | | | -3.08 | (-6.64) | *** |
| Orthodox Christian (%) | | | | | 7.22 | (2.21) | * |
| Education * Time Period | | | -2.77 | (-1.94) | + -2.87 | (-2.09) | * |
| Intercept | 29.74 | (11.21) *** | 30.03 | (11.02) *** | 42.36 | (9.14) | *** |
| lamda | 0.48 | ( 10.47) *** | 0.47 | ( 10.15) *** | 0.42 | ( 9.19) | *** |
| log likelihood | -2183 | | -2180 | | -2154 | | |
| n | 604 | | 604 | | 604 | | |

+p≤.10;*p≤.05;**p≤.01;***p≤.001

*All estimates are derived using a boundary share weight matrix.

## Conclusion & Discussion

***The association between a kebele's socioeconomic status its AIDS mortality is not the same before and after the introduction of anti-retroviral therapy.*** The implication is that the rollout of anti-retroviral therapy has changed some relationships (education and AIDS mortality) while others have remained the same (wealth and AIDS mortality).

***Education is positively associated with AIDS mortality before the rollout of anti-retroviral therapy, but demonstrates a significant negative association subsequent to its introduction, controlling for kebele characteristics such as wealth.*** This suggests that the rollout of anti-retroviral therapy has been associated with a marked reversal in the relationship between the level of education of a kebele and its estimated AIDS mortality.

***Wealth has a significant negative association with AIDS mortality before and after the rollout of anti-retroviral therapy.*** Unlike education and AIDS mortality, wealth had no significant interaction with time period, suggesting that wealthier kebeles have enjoyed lower AIDS mortality before and after the rollout of anti-retroviral therapy when compared to their less wealthy equivalents.

## Limitations

- The measures of socioeconomic status are derived from the 1994 census, the best available source for these measures, which prevents the estimates to account for any subsequent changes in these measures.
- The measured shift in AIDS mortality as it relates to socioeconomic status could be due to unmeasured changes in the epidemiology unrelated to the rollout of ART.

## Acknowledgments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Penn Demography