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A Subnational Examination of HIV/AIDS Mortality Rates in Mexico as a Function of the Social Gap Index and Multidimensional Poverty

Harini Vakamudi

ABSTRACT

A subnational examination of HIV/AIDS mortality rates in Mexico as a function of the Social Gap Index and multidimensional poverty

By

Harini Vakamudi

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Background: While Mexico has maintained a relatively low prevalence of HIV/AIDS and provides universal coverage of highly active antiretroviral therapy (HAART), HIV/AIDS mortality rates have failed to decrease at the national level. However, national trends mask heterogeneity in HIV/AIDS incidence and mortality across states and regions, a finding which likely parallels the distribution of social and economic inequality in Mexico.

Objectives: As HIV/AIDS mortality likely differs as a function of community social and material deprivation, I evaluated the states' annual HIV/AIDS mortality rates in Mexican residents aged 15 and over as a function of the Social Gap Index (SGIx) for each year from 2004-2011. Additionally, I evaluated the relationship between indicators of a state's educational attainment, healthcare deprivation, and prevalence of poverty with annual mortality rates for each year from 2004-2011.

Methods: Using demographic information and mortality data from the Mexican Ministry of Health's Epidemiological and Statistical Mortality System and population level measures of social and material deprivation from The National Council for Evaluation of Social Development and Policy, univariate regression analysis and Pearson correlation were conducted to examine the relationship between annual mortality rate with state level indicators of educational gap, healthcare access, and poverty. Additionally ANOVA was conducted to examine the relationship with between annual mortality rate and state SGIx. All analyses were conducted for each year from 2004-2011.

Results: Mean annual mortality rate at the national level steadily increased from 2005 (M=3.11, SD=1.67) to 2011 (M=3.97, SD=2.32), with the greatest mortality rate in the state of Tabasco (10.45 per 100,000) in 2010. Regression analysis and Pearson correlation indicated no statistically significant relationship between annual mortality and the component variables at the state level. Similarly, the relationship between state SGIx score and annual mortality rate was not statistically significant.

Conclusions: This study demonstrates the limited predictive validity of state and population level measures in determining HIV/AIDS mortality rates. This is likely due to the concentration of HIV/AIDS among high-risk subpopulations in Mexico. Coupled with the limited effectiveness of universal HAART therapy, this suggests the need for future research which specifically samples from high-risk population groups, including men who have sex with men and female commercial sex workers.

A SUBNATIONAL EXAMINATION OF HIV/AIDS MORTALITY RATES IN MEXICO AS A FUNCTION OF THE SOCIAL GAP INDEX AND MULTIDIMENSIONAL POVERTY

by

HARINI VAKAMUDI

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ATLANTA, GEORGIA
30303

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by

HARINI VAKAMUDI

Approved:

Richard Rothenberg
Committee Chair

Betty Lai
Committee Member

July 6, 2016
Date

Author's Statement Page

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Harini Vakamudi
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Introduction

Since the emergence of HIV/AIDS in the Americas, Mexico has maintained a relatively low rate of HIV/AIDS infection, with approximately 0.2% of the population age 15 and older (170,000) infected (Gutierrez et al., 2011). Despite a low prevalence of HIV/AIDS infection and universal coverage of highly active antiretroviral therapy (HAART) since 2003, HIV/AIDS mortality rates have failed to decrease at the national level. Contributing factors include low HAART coverage and adherence, late diagnosis, and late presentation for treatment. However, national trends mask heterogeneity in HIV/AIDS incidence and mortality across states and subpopulations, a finding which likely parallels the distribution of social and economic inequality in Mexico (Hernandez-Avila et al., 2015; Strathdee & Magis-Rodriguez, 2008).

While previous literature has demonstrated significant between state variations in HAART effectiveness, it has been inconclusive on the relationship between socioeconomic disparities and HIV/AIDS mortality rates (Hernandez-Avila, 2015). The ultimate scarcity of literature addressing the influence of universal HAART coverage on HIV/AIDS mortality trends in Mexico and the inconclusive findings of previous studies emphasizes the need for further examination at the subnational level.

As such, I aim to evaluate HIV/AIDS mortality rates in Mexican residents aged 15 and over as a function of the social gap index, (SGIx), a multidimensional measure of states' socioeconomic inequality as indicated by the following domains: educational attainment, access to basic services, access to healthcare services, and quality of home and living spaces. Furthermore, I will evaluate the relationship between a state's prevalence of poverty, level of educational attainment, and access to healthcare services with mortality rates, ultimately hypothesizing higher mortality as a function of greater socioeconomic deprivation as indicated by both multidimensional and individual measures.

Background

In 2001, Mexico's federal government executed comprehensive healthcare reform policies, including the introduction of the National System for Social Protection in Health or Seguro Popular, a federal program which provides comprehensive health insurance to previously uninsured Mexicans through state governments (Frenk, 2006; Gonzalez-Pier, 2006; Gonzalez, 2011). The reform also includes universal coverage of HAART, a policy which was fully implemented as of 2003 (Bautista-Arredondo, 2013; Stevens, 2008). The extant literature demonstrates the effectiveness of universal HAART therapy in other low and middle income countries. In Spain, government coverage of HAART therapy resulted in a three-fold decrease in HIV/AIDS mortality rates (MSSSI, 2012, as cited in Hernandez-Avila, 2015). Similarly, HAART programs in Thailand, South Africa, Brazil, and Malawi resulted in a decrease in HIV/AIDS mortality (Badri, 2006; Chasombat, 2009; Ferradini, 2006; Marins, 2003; as cited in Hernandez-Avila, 2015).

However, findings have not been replicated in Mexico, where mortality trends have been inconsistent at the state level (Strathdee & Magis-Rodriguez, 2008). Hernandez-Avila et al., (2015) evaluated state HIV/AIDS mortality rates for two populations: those covered through traditional health insurance and those covered through Seguro Popular to examine differential trends and evaluate the predictive validity of the marginalization index. While some states (Jalisco, The Federal District, and Puebla) demonstrate significant, sustained reductions in HIV/AIDS mortality in both populations, other states demonstrate varied trends, with either

increasing mortality rates or reductions in mortality limited to the traditionally insured population. Additionally, associations between the marginalization index and mortality rates in either group were inconsistent between states.

Heterogeneity in Seguro Popular's effectiveness may be due to disparities in medical access, which culminates in outcomes such as inadequate HAART coverage. Currently, less than 50% of HAART candidates are receiving treatment; furthermore, data from the National Center for AIDS Prevention and Control indicates that, as of 2009, only 14% of HIV/AIDS infected adults were receiving medical follow-while 59% were either unaware of their HIV/AIDS status or not receiving medical follow-up (Avila-Rios, 2011; Gonzalez, 2011) Barriers to HAART treatment include stigma and discrimination at the interpersonal and healthcare levels, inefficient diagnostic methods, and lack of comprehensive case management, which contributes to loss to follow up (Crabtree-Ramirez, 2011; Strathdee & Magis-Rodriguez, 2008).

This is substantiated by the clustering of HIV/AIDS in highly marginalized, key populations including injection drug users, commercial sex workers, and men who have sex with men (Bautista-Arredondo, 2013; Gonzalez, 2011; Strathdee & Magis-Rodriguez, 2008). The result is late diagnosis, late initiation of treatment, and poor medication adherence, which contribute to reduced effectiveness of HAART and greater mortality. An evaluation of HIV/AIDS-related patient deaths at a three hospitals in Mexico City demonstrated that 51% of patients had received less than 6 months of HAART and 40.5% had never received HAART, with 18% of patients aware of their HIV/AIDS status (Martín-Onraet, 2015).

The differential presence of marginalized populations, prevalence of poverty, educational attainment, and healthcare access between states supports the argument for regional differences in HIV/AIDS diagnosis, treatment, management, and subsequent mortality. Despite Mexico's status as a middle income country, the population has undergone an unequal epidemiological transition with regionally variable morbidity, mortality, and quality of life, with the most economically disadvantaged states of Southern Mexico demonstrating a double burden of disease, characterized by a higher prevalence of both communicable and non-communicable diseases and causes of death, as well as undernutrition (Frenk, 2006; Gonzalez-Pier, 2006; Stevens, 2008).

This is consistent with the findings of Ortiz-Hernandez (2015), which demonstrate an association between socioeconomic status and education and poorer health outcomes, including a higher burden of chronic and infectious diseases. Specifically, populations with lower educational attainment and income levels demonstrate a greater burden of morbidity and mortality, report less access to healthcare services, are less likely to be tested for HIV/AIDS or access HIV/AIDS services, and are more likely to engage in high-risk behaviors, including unprotected sexual intercourse. Similarly, Crabtree-Ramirez et al. (2011; 2012) found that late diagnosis of HIV/AIDS was negatively associated with income and years of education completed and positively associated with unemployment, while the risk of late HAART initiation was negatively associated with educational attainment.

However, socioeconomic deprivation is a multidimensional concept, and as such, can be difficult to quantify. The development of national indices of deprivation, (e.g., Indices of Multiple Deprivation in the United Kingdom, Quebec and Canadian Indices of Material and Social Deprivation) has provided a means to measure both social and material deprivation at the national, regional, and municipal level through common dimensions, including education, healthcare, quality of housing/living environment, and access to basic services (Pampalon et al., 2012; Payne & Abel, 2012; Yuan & Wu, 2014). Though the validity of individual indices is

uncertain, the extant literature demonstrates the use of multidimensional indices to capture social inequities, (e.g., healthcare disparities), characterize population health status, and, most importantly, utilize findings to develop cost-effective policy and government interventions that target the most vulnerable segments of the population (Aguila et al., 2014; Pampalon, 2012, Payne & Abel, 2012; Vasquez et al., 2016).

In Mexico, the Social Gap Index (SGIx), a multidimensional index created by the National Council for the Evaluation of Social Development and Policy (CONEVAL), can be similarly utilized to examine the relationship between social deprivation and population health status. Previous literature has demonstrated an association between SGIx and a variety of health indicators and disease outcomes, including iodine nutrition, osteoarthritis, and depressive symptoms among older adults (Fernandez-Nino et al., 2014; Garcia-Solis et al., 2013; Rodriguez-Amado et al., 2016). Coupled with the crucial role of state governments in the administration of Seguro Popular, I argue that examining differential HIV/AIDS mortality trends as a function of SGIx can provide a tool to develop cost-effective, targeted federal and state policy and interventions to encourage early, consistent HAART coverage and reduce HIV/AIDS mortality among vulnerable populations.

Methods

Participants and data sources

Demographic information and mortality data were obtained from the Mexican Ministry of Health's Epidemiological and Statistical Mortality System, the national database that collects and manages information and documentation of all deaths that occurred in a healthcare setting (i.e., death certificates). For this study, data was obtained at the individual for Mexican residents who 1) were aged 15 and older at the time of death and 2) died of an HIV/AIDS attributed cause of death from 2004-2011. An HIV/AIDS cause of death was defined according to the International Classification of Disease (ICD) cause of death codes (ICD-9: 279.5 and 279.6 and ICD-10: B.20-B.24). Minimum age of inclusion was set at 15 as all population level measures were obtained for residents aged 15 and older. 29147 participants were included in the mortality dataset, of whom 21 were excluded due to missing information for state of death, leaving a total of 29126 participants.

Population level measures were extracted from CONEVAL and based on the Socioeconomic Module of the National Survey of Income and expenditure of Households (MCS-ENIGH), administered by Mexico's National Statistics and Geographic Institute. The MCS-ENIGH utilizes a stratified, random sampling design in which households are randomly selected from catchment areas. Specifically, it utilizes the National Geostatistical Framework, which is comprised of state, municipal, and basic geostatistical areas. The MCS-ENIGH stratifies basic geostatistical areas into 5 components, based on geographic and socioeconomic factors. Households are then randomly selected from urban and rural blocks within these strata and interviewed. As such, all population level measures included are based on self-report. A more detailed description of participants, survey, methodology, and sampling framework is available elsewhere (Aguila, 2014).

As the MCS-ENIGH is only administered biennially, with measures of social and material deprivation and poverty reported quinquenially and biennially, respectively, mortality rates were analyzed against measures from the most recent administration of the MCS-ENIGH, with 2000 data used for the year 2004, 2005 data used for the years 2005-2009, 2008 data used for the years 2008-2009, and data from 2010 used for the years 2010-2011 (Table 1).

Measures

Mortality rate

Mortality rate for each of Mexico's 32 states was calculated using state population estimates, reported by CONEVAL for 2000, 2005, and 2010, and crude mortality data from the Mexican Ministry of Health's Epidemiological and Statistical Mortality System. Specifically, the number of deaths per state per year for 2004-2011 was divided by the state's population estimate from the most recent administration of the MCS-ENIGH (i.e., 2000 for 2004, 2005 for 2005-2009, and 2010 for 2010-2011) in order to calculate the annual mortality rate per 100,000 (Table 1).

SGIx

SGIx is an ordinal measure of social and material deprivation, constructed by CONEVAL based on measures obtained by the MCS-ENIGH in household surveys. The indicators encompass four domains (healthcare access, education, access to basic services at home, quality of the home and living spaces) and are as follows: the proportion of the population aged 15 and older that is illiterate, aged 15 and older who did not complete basic educational requirements, proportion of children aged 6-14 that do not attend school or have a primary education, proportion without access to healthcare services, the proportion living in a home with dirt floors, without sanitation facilities, running water, a sewage system, electricity, a washing machine, or a refrigerator, and the average number of persons per room).

Based on the proportion of the population within a specific geographical area that falls into these categories of deprivation, CONEVAL uses principal component analysis to construct a numerical score to represent state, municipal, and local levels of deprivation. Using the Dalenius and Hodges' technique of minimum variance, this score is then stratified into five degrees of social gap (very low, low, medium, high, very high) in ordinal categories which can be used to represent multidimensional deprivation (Dalenius & Hodges 1957; 1959, as cited in Aguila, 2014). For the purposes of this study, state SGIx scores from 2000, 2005, and 2010 were used, with scores for 2000 used for 2004, scores for 2005 used for 2005-2009, and scores for 2010 used for 2010-2011. A more detailed description of the methodology and formula used by CONEVAL to calculate SGIx scores are discussed elsewhere (Aguila, 2014; CONEVAL, 2007).

Education and healthcare

The measure of a state's gaps in education is operationalized as the rate of illiteracy in individuals 15 and older, the percent of the population aged 6 to 14 who do not attend school, and the percent of the population aged 15 and older who have not completed basic schooling (i.e., the federally mandated minimum schooling requirement). These percentages are obtained based on data collected by the MCS-ENIGH during household surveys and are reported on a quinquennial basis by CONEVAL.

Similarly, the measure of healthcare deprivation, operationalized as a self-reported lack of access to healthcare, is obtained during the administration of the MCS-ENIGH. Lack of access to healthcare is further defined as when an individual is not enrolled in or entitled to health insurance coverage, benefits, and care, either through public or private institutions and programs (e.g., Seguro Popular, Social Security Institutions) (CONEVAL, 2010). As the aforementioned information is only published quinquenially, for the purposes of this study, measures from the 2000, 2005, and 2010 CONEVAL datasets were used, with measures for 2000 used for 2004,

measures for 2005 used for 2005-2009, and measures for 2010 used for 2010-2011 (Table1).

Poverty

The population level indicators of poverty that were included in this study were the proportion of a state's population living in poverty and the proportion living in extreme poverty, which is published by CONEVAL. This data is based on the MCS-ENIGH, which assesses a household's financial status according to self-reported income, assets, and expenditures (Aguila, 2014). CONEVAL and the MCS-ENIGH define individuals living in poverty defined as those whose income falls below the wellbeing threshold (i.e., "the income needed to afford basic food and non-food baskets of goods and services") and who are deprived in at least one social dimension (educational lag, lack of access to healthcare services, lack of access to social security, housing of inadequate quality or insufficient space, lack of basic housing services, and lack of access to food). Within this population, individuals living in extreme poverty are defined as those with an income below the minimum wellbeing threshold and with at least three deprivations in the aforementioned social dimensions (CONEVAL, 2014). As data on income and poverty is collected on a biennial basis, for the purposes of this study, estimates of poverty from 2008 and 2010 were used, with data for 2008 used for 2008-2009 and data for 2010 used for 2010-2011 (Table 1).

Analytic Plan

Univariate regression analysis was conducted to examine the relationship between indicators of educational gaps (rate of illiteracy in individuals 15 and older, percent of population aged 6 to 14 who do not attend school, percent of population aged 15 and older who have not completed basic schooling) and annual mortality rates for each state from 2004-2011. Univariate regression analysis was similarly used to examine the relationship between healthcare deprivation (percent of population without access to healthcare services) and annual mortality rates, as well as poverty (percent of population in poverty, percent in extreme poverty) with annual mortality rates, for each state from 2004-2011.

Additionally, Pearson's correlation was conducted to determine the correlation between the rate of illiteracy in individuals 15 and older, percent of population aged 6 to 14 who do not attend school, percent of population aged 15 and older who have not completed basic schooling, lack of healthcare access, poverty, and extreme poverty with annual mortality rate for each state from 2004-2011, respectively. Analysis of variance (ANOVA) was utilized to identify differences in mean annual mortality rate between SGIx strata (very low, low, medium, high, and very high) and annual mortality rates for each year from 2004-2011.

As the MCS-ENIGH is only administered biennially, with measures of social and material deprivation and poverty reported quinquenially and biennially, respectively, mortality rates were analyzed against predictors from the most recent administration of the MCS-ENIGH. Specifically, measures from 2000 were examined with the mortality rate in 2004, measures from 2005 were examined with mortality rates from 2005-2009, measures from 2008 were examined with mortality rates in 2008-2009, and measures from 2010 were examined with mortality rates from 2010-2011. All data analyses were performed in SAS 9.4 (SAS Institute, 1989-2013).

Results

Mean annual mortality rate at the national level steadily increased from 2005 (Mean=3.11, Standard Deviation=1.67) to 2011 (M=3.97, SD=2.32), with the greatest mortality

rate in Tabasco (10.45 per 100,000) in 2010 and the lowest (0.84 per 100,000) in Aguascalientes in 2011 (Table 2; Figure 1). In contrast, population level measures of social and material deprivation showed a slight decrease at the national level from the 2000 to the 2010 administration of the MCS-ENIGH (Table 2), with illiteracy decreasing from 9.47% (SD=5.43%) to 6.78% (SD=4.23%); proportion of children not attending school decreasing from 7.94% (SD=2.38%) to 4.58% (SD=1.28%); proportion of the population over 15 with incomplete basic education decreasing from 55.63% (SD=9.09%) to 41.33% (SD=8.25%), and the proportion of the population without access to healthcare services decreasing from 55.86% (SD=13.76%) to 30.38% (SD=8.59%) (Table 2). Measures of economic deprivation showed mixed trends, with the mean national percentage of individuals living in extreme poverty decreasing from the 2008 (M=10.04%, SD=8.40%) to the 2010 (M=9.75%, SD=7.61%) administration of the MCS-ENIGH, while the percentage living in poverty demonstrated a marginal increase, from 43.48% (SD=14.09%) to 45.87% (SD=13.41%) (Table 2). Mean annual mortality rate across SGIx strata failed to exhibit any trends, with no consistency in mean annual mortality rate within a stratum across years or the expected increase in mean annual mortality with higher degrees of deprivation (Table 3).

Univariate regression analysis indicated that the relationship between the proportion of a state's population without access to healthcare services and annual mortality rate is not statistically significant for 2004-2011 (Table 4). Similarly the relationships between annual rate of illiteracy, proportion aged 6-14 who do not attend school, proportion aged 15 and over who did not complete basic schooling, and the percent living in poverty and extreme poverty do not have a statistically significant relationship with state mortality rate for any year (Table 4). Additionally, Pearson's correlation failed to demonstrate a statistically significant relationship between component variables and mortality rate for 2004-2011 (Table 5). The results of the ANOVA also did not demonstrate a statistically significant difference in mean annual mortality rate between any SGIx strata during any year from 2004-2011 (Table 6).

Discussion

Results of univariate regression analysis and ANOVA failed to support the hypothesis that socioeconomic deprivation at the state level is predictive of HIV/AIDS a state's annual HIV/AIDS mortality rate. Specifically, univariate regression analysis indicates no statistically significant relationship between annual mortality rate and indicators of educational attainment and healthcare access, while the ANOVA did not demonstrate a significant relationship between SGIx and annual mortality rate. This is consistent with previous literature, which indicates a relationship between socioeconomic deprivation and morbidity and mortality at the individual, local, and municipal level, as opposed to the state level. In a study of depressive symptoms in older adults in Mexico, Fernandez-Nino (2014) demonstrates a relationship between the marginalization index and depressive symptoms at the local and municipal level; however, the study did not find a significant relationship at the state level. Hernandez-Nino (2014) similarly failed to establish a consistent relationship between SGIx and HIV/AIDS mortality at the state level in Mexico, suggesting that factors relevant to HIV/AIDS mortality are more likely influential at the individual and community levels.

This is further evidenced by the geographic and demographic clustering of HIV/AIDS among high risk populations, including men who have sex with men, commercial sex workers, injection drug users, and migrants; as these high risk groups are not representative

of the general population, population level measures, such as those utilized in our study (i.e., state SGIx, healthcare access, and educational attainment), may not influence mortality among people living with HIV/AIDS. For instance, while the national prevalence of HIV/AIDS is estimated at 0.1-0.3%, the prevalence among populations of men who have sex with men has been estimated at 10-16.9%; similarly, the prevalence among populations of female commercial sex workers who inject drugs has been estimated at 12% (National Center for AIDS Prevention and Control, 2009; Gayet et al., 2007; Magis et al., 2005; Strathdee et al., 2008). Additionally, official estimates from the Mexican Ministry of Health indicate that, as of 2013, 44 cities in Mexico contained 72% of HIV/AIDS cases among men who have sex with men (as cited in Bautista-Arredondo, 2013.

Additionally, the stigmatized nature of living with HIV/AIDS, commercial sex work, and same-sex sexual relationships in Mexico likely results in social exclusion, which nullifies the influence of population level socioeconomic characteristics, instead favoring immediate socioeconomic factors at the immediate and community level (Gonzalez, 2011; Hirsch et al., 2012; Orozco-Nunez et al., 2015; Strathdee & Magis-Rodriguez, 2008; Torres-Ruiz, 2011). Coupled with the protective effects of social support, educational attainment, and access to coverage and care through social security institutions (only available to individuals with jobs in the formal economy), this ultimately suggests that population -level measures of poverty and socioeconomic deprivation are not necessarily valid predictors of HIV/AIDS mortality, but rather the lack of participation in formal social and economic spheres of society (Bautista-Arredondo, 2014; Campero et al., 2007; Crabtree-Ramirez, 2011; Hernandez-Avila, 2015).

Limitations of the study include the sampling strategy and periodicity of the MCS-ENIGH, underreporting and misreporting of HIV/AIDS, and population mobility. Briefly, as previously stated, the MCS-ENIGH utilizes a random sampling design in which basic geostatistical areas are stratified according to socioeconomic factors, after which households are randomly selected and interviewed from within these strata. However, HIV/AIDS is a targeted epidemic, concentrated among high-risk, minority groups that are not adequately captured by a geographically based randomized sampling design; as such, the MCS-ENIGH sample may not be representative of populations relevant to HIV/AIDS infection and mortality. Additionally, members of the high-risk groups among whom HIV/AIDS is clustered either may not reside in traditional, accessible neighborhoods due to social exclusion (e.g., commercial sex workers) or do not maintain a permanent residence (e.g., migrants). The culmination of these factors is that the population level measures provided by the MCS-ENIGH have limited utility in estimating morbidity and mortality among such a targeted epidemic.

Additionally, the MCS-ENIGH is only administered biennially, while the majority of the indicators utilized in this study are reported on a quinquennial basis. Despite these “gaps” in administration and publication of data, mortality rates were calculated on an annual basis from 2004-2011 using state population estimates from the 2000, 2005, and 2010 datasets. As annual mortality rate was the primary study outcome under assessment, the potential error introduced into calculations by outdated or inaccurate population estimates may have impeded proper assessment of relationships between study variables. Similarly, values for indicators of deprivation in education and healthcare access and poverty were only available for 2000, 2005, 2010 and 2008, 2010, respectively; however, these measures were applied to all years from 2004-2011and utilized in subsequent statistical analysis.

Errors in annual mortality data may have also been introduced by misclassification and underreporting of HIV/AIDS attributed deaths. Specifically, the mortality data obtained from the Ministry of Health's Epidemiological and Statistical Mortality System is subject to potential misclassification and selection bias. For instance, the migrant nature of laborers and commercial sex workers may lead to disparities between state of residence and the state of death reported on an individual's death certificate, skewing annual mortality samples for each state (Strathdee & Magis-Rodriguez, 2008). Additionally, mortality data is only available for deaths that occurred in a healthcare setting, specifically a setting in which a physician or other healthcare personnel could record and register the patient's demographic and mortality information with the local health department. As the HIV/AIDS epidemic in Mexico has been characterized by low testing rates and late presentation for treatment, the Epidemiological and Statistical Mortality System likely fails to capture a significant portion of HIV/AIDS attributed deaths.

HIV/AIDS mortality rates may also be skewed by misreporting of causes of death on patient death certificates. A study by Cahuana-Hurtado et al., (2011) concluded that 11% of HIV/AIDS attributable deaths had been misreported, which suggests an underreporting of HIV/AIDS mortality in Mexico. Similar underreporting has been identified in South Africa and Brazil, due to unknown HIV status, social stigma, poor coding quality, variability in local levels of medical training, and pressure from patients and doctors to exclude HIV status on death certificates due to confidentiality concerns (Birnbaum et al., 2011; Fazito et al., 2012). While Mexico maintains "good quality" mortality records, late presentation for treatment, low testing rate, and lack of integrated care among most HIV positive individuals likely contributes to misclassification; additionally, social stigma surrounding homosexuality and confidentiality concerns likely also contribute to hesitation from patients and physicians to disclose HIV status on death certificates (Avila-Rios, 2011; Cahuana-Hurtado, 2011; Crabtree-Ramirez, 2011; Gonzalez, 2011; Martin-Onraet, 2015; Torres-Ruiz, 2011).

This study demonstrates the limited predictive validity of state and population level factors in determining HIV/AIDS mortality rates. The targeted nature of the HIV/AIDS epidemic in Mexico precludes the use of ecological analysis in predicting morbidity and mortality, as the individuals and groups contributing to population level measures of economic and social disparities are not representative of those in which HIV/AIDS is most concentrated. Coupled with the limited effectiveness of universal HAART therapy, as indicated by heterogeneity in the reduction of the HIV/AIDS mortality rate in Mexico, this suggests the need for research to examine HIV/AIDS mortality at the individual and community level. This includes the need for future studies which specifically sample from high-risk population groups, including men who have sex with men and commercial sex workers. These findings could hopefully be used to develop targeted policy initiatives to improve early testing, timely initiation of HAART, and improved adherence to treatment at the individual and community level, while also paving the way for reduced stigma and discrimination against people living with HIV/AIDS at the societal and political level.

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Table 1
Variable sources and calculations.

Variable	Dataset(s)
% >15 who are illiterate	
2004	CONEVAL (2000)*
2005-2009	CONEVAL (2005)
2010-2011	CONEVAL (2010)
% 6-14 not attending school	
2004	CONEVAL (2000)
2005-2009	CONEVAL (2005)
2010-2011	CONEVAL (2010)
% >15 with incomplete basic education	
2004	CONEVAL (2000)
2005-2009	CONEVAL (2005)
2010-2011	CONEVAL (2010)
% without access to healthcare	
2004	CONEVAL (2000)
2005-2009	CONEVAL (2005)
2010-2011	CONEVAL (2010)
% in poverty	
2004	CONEVAL (2000)
2005-2009	CONEVAL (2005)
2010-2011	CONEVAL (2010)
% in extreme poverty	
2008-2009	CONEVAL (2008)
2010-2011	CONEVAL (2010)
SGIx**	
2004	CONEVAL (2000)
2005-2009	CONEVAL (2005)
2010-2011	CONEVAL (2010)
Mortality rate***	
2004	CONEVAL (2000), SEED (2004)*
2005	CONEVAL (2005), SEED (2005)
2006	CONEVAL (2005), SEED (2006)
2007	CONEVAL (2005), SEED (2007)
2008	CONEVAL (2005), SEED (2008)
2009	CONEVAL (2005), SEED (2009)
2010	CONEVAL (2010), SEED (2010)
2011	CONEVAL (2010), SEED (2011)

* CONEVAL – National Council for the Evaluation of Social Development and Policy; SEED – Epidemiological and Statistical Mortality System

** SGIx scores are constructed and published by CONEVAL and are based on the values for the following indicators: the proportion of the population aged 15 and older that is illiterate, aged 15 and older who did not complete basic educational requirements, proportion of children aged 6-14 that do not attend school or have a primary education, proportion without access to healthcare services, the proportion living in a home with dirt floors, without sanitation facilities, running water, a sewage system, electricity, a washing machine, or a refrigerator, and the average number of persons per room.

*** Mortality rate is calculated (per 100,000) on an annual basis for each state using population estimates from CONEVAL and mortality estimates from SEED.

Table 2

Descriptive statistics for annual mortality rate and indicators of educational deprivation, healthcare access, and poverty from 2004-2011 at the national level

Year	Mortality Rate[a]**		Illiteracy[b] (%)		School Attendance[c] (%)		Completion of Education (%)		Lack of Healthcare Access[e] (%)		Poverty[f] (%)		Extreme Poverty[g] (%)	
	M	*SD**	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
2004	3.50	2.03	9.47	5.43	7.94	2.38	55.63	9.09	55.86	13.76				
2005	3.11	1.67	8.35	4.99	5.05	1.41	46.74	8.49	46.63	15.23				
2006	3.39	1.90												
2007	3.44	1.92												
2008	3.55	2.07									43.48	14.09	10.04	8.40
2009	3.94	2.24												
2010	3.85	2.18	6.78	4.23	4.58	1.28	41.33	8.25	30.38	8.59	45.87	13.41	9.75	7.61
2011	3.97	2.32												

* M – mean; SD – standard deviation

** From left to right, columns indicate year of measurement and mean national values of (a) mortality rate per 100,000, (b) percent of population 15 and over who are illiterate, (c) percent of population 6-14 who do not attend school, (d) percent of population 15 and older with incomplete education, (e) percent of population without healthcare access, (f) percent of population living in poverty, and (g) percent of population living in extreme poverty.

Table 3

Mean annual mortality rate across SGIx strata.

Year	2004		2005		2006		2007		2008		2009		2010		2011	
SGIx Stratum	*M*	*SD**	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Very Low	4.02	2.65	3.34	1.79	3.38	1.78	3.51	2.21	3.54	1.91	3.96	2.22	3.86	1.47	4.05	2.15
Low	3.76	1.19	2.90	1.17	3.45	1.81	3.27	1.44	3.73	1.94	3.22	1.25	4.03	2.58	4.39	2.51
Medium	3.40	2.43	3.37	2.41	3.62	2.77	3.41	2.53	3.54	2.95	4.56	3.33	3.68	3.41	3.59	3.37
High	2.76	0.79	2.63	1.65	2.88	1.82	3.52	2.21	3.40	2.36	3.75	2.48	3.69	2.26	3.78	2.34
Very High	4.41	2.65	3.32	0.97	3.83	1.23	3.47	0.88	3.60	0.87	4.23	1.08	4.13	0.56	3.91	0.54

* M – mean; SD – standard deviation

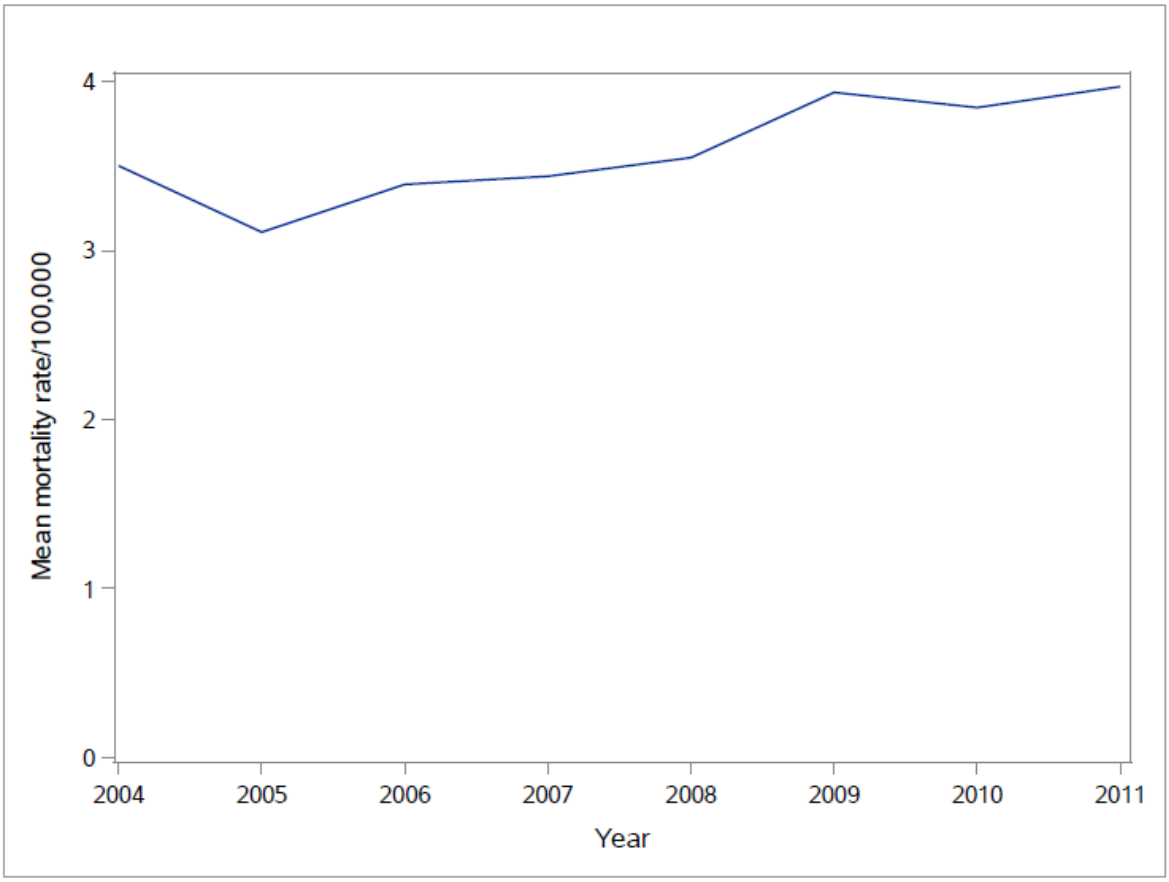

Fig. 1. Mean national HIV/AIDS mortality rate: Mexico (2004-2011).

Table 4
Univariate regression analysis of the relationship between annual mortality rate and educational deprivation, healthcare access, and poverty at the state level from 2004-2011

Year	2004		2005		2006		2007		2008		2009		2010		2011	
Independent Variables	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Illiteracy[a]*	-0.03	0.07	0.01	0.06	0.02	0.07	0.03	0.07	0.01	0.08	0.05	0.08	0.02	0.09	0.01	0.10
p	0.62		0.83		0.76		0.69		0.91		0.55		0.83		0.96	
School Attendance[b] *p*	-0.03	0.16	0.01	0.22	0.03	0.25	0.07	0.25	-0.11	0.27	-0.03	0.29	0.02	0.31	0.06	0.33
	0.86		0.96		0.89		0.77		0.69		0.92		0.95		0.86	
Completion of Education[c] *p*	-0.05	0.04	-0.02	0.04	-0.02	-0.45	-0.01	0.04	-0.03	0.04	-0.02	0.05	-0.03	-0.66	-0.03	0.05
	0.22		0.64		0.66		0.96		0.50		0.63		0.52		0.49	
Healthcare Access[d] *p*	-0.02	0.03	-0.01	0.02	-0.02	0.02	-0.03	0.02	-0.03	0.02	-0.02	0.03	-0.01	0.05	-0.03	0.05
	0.44		0.55		0.46		0.24		0.21		0.52		0.69		0.45	
Poverty[e] *p*									-0.02	0.03	-0.01	0.03	-0.01	0.03	-0.02	0.03
									0.41		0.78		0.81		0.61	
Extreme Poverty[f] *p*									0.01	0.04	0.02	0.05	0.01	0.05	-0.01	0.06
									0.92		0.63		0.87		0.90	

* From top to bottom, rows represent the following component variables: (a) percent of population 15 and over who are illiterate, (b) percent of population 6-14 who do not attend school, (c) percent of population 15 and older with incomplete education, (d) percent of population without healthcare access, (e) percent of population living in poverty, and (f) percent of population living in extreme poverty.

Table 5

Pearson correlation coefficient of relationship between annual mortality rate and educational deprivation, healthcare access, and poverty at the state level from 2004-2011

Year	**2004**		**2005**		**2006**		**2007**		**2008**		**2009**		**2010**		**2011**	
Independent Variables	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p
Illiteracy[a]*	-0.09	0.62	0.04	0.83	0.06	0.77	0.08	0.69	0.02	0.91	0.11	0.56	0.04	0.83	0.01	0.96
School Attendance[b]	-0.04	0.86	0.01	0.96	0.03	0.89	0.05	0.77	-0.07	0.69	-0.02	0.92	0.01	0.95	0.03	0.86
Completion of Education[c]	-0.22	0.22	-0.09	0.64	-0.08	0.66	-0.01	0.96	-0.12	0.50	-0.09	0.63	-0.12	0.52	-0.13	0.49
Healthcare Access[d]	-0.14	0.44	-0.11	0.55	-0.14	0.46	-0.22	0.24	-0.23	0.21	-0.12	0.52	-0.07	0.69	-0.14	0.45
Poverty[e]									-0.15	0.41	-0.05	0.71	-0.04	0.81	-0.09	0.61
Extreme Poverty[f]									0.02	0.92	0.09	0.63	0.03	0.87	-0.02	0.90

* From top to bottom, rows represent the following component variables: (a) percent of population 15 and over who are illiterate, (b) percent of population 6-14 who do not attend school, (c) percent of population 15 and older with incomplete education, (d) percent of population without healthcare access, (e) percent of population living in poverty, and (f) percent of population living in extreme poverty.

Table 6

Analysis of variance (ANOVA) comparing mean annual mortality rate across SGIx strata at the state level from 2004-2011

Year	Sum of Squares	df	Mean square	F	p
2004					
Between*	15.85	4	3.96	0.96	0.45
Within**	111.43	27	4.13		
Total	127.28	31			
2005					
Between	2.98	4	0.75	0.24	0.91
Within	83.16	27	3.08		
Total	86.15	31			
2006					
Between	0.26	4	0.07	0.02	0.99
Within	114.56	27	4.24		
Total	114.82	31			
2007					
Between	3.01	4	0.75	0.19	0.94
Within	109.05	27	4.04		
Total	112.06	31			
2008					
Between	0.37	4	0.09	0.02	0.99
Within	132.52	27	4.91		
Total	132.89	31			
2009					
Between	6.33	4	1.58	0.29	0.88
Within	149.39	27	5.53		
Total	155.71	31			
2010					
Between	0.84	4	0.21	0.04	0.99
Within	146.42	27	5.42		
Total	147.26	31			
2011					
Between	2.42	4	0.61	0.10	0.98
Within	165.11	27	6.12		
Total	167.53	31			

* Between group differences. Comparison of mean annual mortality rate across SGIx stratum for the given year.

**Within group differences. Comparison of mean annual mortality rate across all observations for the given year.