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Socioeconomic inequalities in premature mortality in Colombia, 1998–2007: The double burden of non-communicable diseases and injuries

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ABSTRACT

Objectives. Non-communicable diseases have become the leading cause of death in middle-income countries, but mortality from injuries and infections remains high. We examined the contribution of specific causes to disparities in adult premature mortality (ages 25–64) by educational level from 1998 to 2007 in Colombia.

Methods. Data from mortality registries were linked to population censuses to obtain mortality rates by educational attainment. We used Poisson regression to model trends in mortality by educational attainment and estimated the contribution of specific causes to the Slope Index of Inequality.

Results. Men and women with only primary education had higher premature mortality than men and women with post-secondary education ($RR_{men} = 2.60$, 95% confidence interval [CI]: 2.56, 2.64; $RR_{women} = 2.36$, CI: 2.31, 2.42). Mortality declined in all educational groups, but declines were significantly larger for higher-educated men and women. Homicide explained 55.1% of male inequalities while non-communicable diseases explained 62.5% of female inequalities and 27.1% of male inequalities. Infections explained a small proportion of inequalities in mortality.

Conclusion. Injuries and non-communicable diseases contribute considerably to disparities in premature mortality in Colombia. Multi-sector policies to reduce both interpersonal violence and non-communicable disease risk factors are required to curb mortality disparities.

Introduction

In most high-income countries, approximately two thirds of socioeconomic inequalities in mortality are attributable to cardiovascular disease and cancer, with less than 5% attributable to injuries and communicable diseases (Huisman et al., 2005). This pattern may be markedly different in low- and middle-income countries, where non-communicable diseases have become a leading cause of death, but mortality from both communicable diseases and injuries remains relatively high (Frenk et al., 1991). While lower socioeconomic status is often associated with higher mortality from 'poverty-related diseases' such as preventable infections (Singh and Singh, 2008), it is less clear how socioeconomic status might relate to conditions associated with modern lifestyles such as cardiovascular disease (Singh and Singh, 2008). The contribution of different causes to socioeconomic inequalities in mortality has been documented in wealthy nations (Fawcett et al., 2005; Huisman et al., 2005; Kunst et al., 1998b; Wong et al., 2002), while few studies have focused on low- and middle-income countries (Belon et al., 2012).

Colombia faces relatively high mortality from communicable diseases and injuries, as well as high mortality from non-communicable diseases (Mayorga, 2004). Rates of premature mortality from non-communicable diseases are comparable to those in high-income countries, while mortality rates from infections and injuries are four times higher (Appendix Fig. 1) (World Health Organization, 2012). This pattern has resulted in a double burden, with injuries and communicable diseases accounting for approximately half of all deaths, and non-communicable diseases for another half (Mayorga, 2004; World Health Organization, 2012). A potential hypothesis is that the increasing burden of non-communicable disease mortality (Mayorga, 2004) has disproportionately affected the lower socioeconomic groups, which also have higher mortality from infectious diseases and injuries (Mayorga, 2004).

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Classified as a middle-high income country (World Bank, 2011), Colombia has experienced improvements in socioeconomic and healthcare indicators over the last decades. Between 1998 and 2007, constant GDP per capita grew on average by 1.9% per year. The percentage of population living in poverty (less than US$2 per day) declined from 14.1% in 1998 to 7.5% in 2007 (World Bank, 2011), and healthcare insurance coverage increased from 59.8% to 92.5% (Arroyave et al., 2013). Educational attainment has also risen (Appendix Fig. 2), with noticeable increases in the proportion of population with secondary and tertiary education (IIASA/VID, 2010). Despite these improvements, inequalities in Colombia remain high by international standards; in 1999–2003, the Gini coefficient of income inequality was 55.9% (World Bank, 2011).

In this study, we examine trends in socioeconomic inequalities in mortality and estimate the contribution of specific causes of death to these differentials between 1998 and 2007 in Colombia. We hypothesized that mortality from non-communicable diseases, infections and injuries contributes each to socioeconomic differences in mortality. However, we expected an increasing concentration of non-communicable diseases in the lower socioeconomic groups, leading to widening socioeconomic inequalities in total mortality.

Methods

Data

Data were obtained from official registries of the National Administrative Department of Statistics, which collects and harmonizes data on deaths based on international guidelines. For all deceased individuals (633,906 deaths), data were collected on sex, age of death and educational level. Causes of death were coded according to the International Classification of Diseases (ICD-10) and aggregated into 10 major causes of death grouped into four broad categories: non-communicable diseases, injuries, infections and other causes. Table-Appendix 1 shows specific ICD-10 codes for each cause of death.

Data on population counts were obtained based on the following procedure: First, we estimated the distribution of education by 5-year age group, sex and year, based on data from censuses and national surveys harmonized by the International Institute of Applied System Analysis (IIASA) and the Vienna Institute of Demography (VID) as part of the IIASA/VID database (IIASA/VID, 2010). We then combined this information with data on national population counts from the National Statistics Office to obtain the number of population by educational attainment. IIASA/VID data were only available per quinquennium; therefore, we performed demographic projections to obtain population counts for in-between years using the demographic software PASEX (U.S. Census Bureau, 2011).

Data on educational level was missing for approximately a third of the deceased cases. We used multiple imputation methods implemented in SAS through the IMPUTE procedure to impute educational level for these cases. This was done to avoid bias due to the potentially higher rates of missing education for lower educated individuals, and to minimize the potential for numerator/denominator bias (Kunst et al., 1998a). This procedure fits a sequence of regression models and draws values from the corresponding predictive distributions. The sequential regression procedure was applied based on a model that included sex, region, age and marital status as covariates. Imputation was not possible in 6.8% of the cases. Full details on the procedure are available elsewhere (Raghunathan et al., 2001).

We distinguished three groups based on their highest educational level attained: (a) completed primary school, (b) completed secondary school, and (c) completed tertiary education. We excluded individuals below age 25, because many would not have completed their education before this age. In addition, we focused on adult premature mortality (mortality below age 65), an indicator of population health believed to be strongly influenced by social, economic and environmental factors (World Health Organization, 2008), and a common indicator of health system performance (Smith et al., 2009). While some premature deaths are unavoidable, a substantial part of premature mortality is avoidable through public health programs and policies that address the social determinants of health (World Health Organization, 2008).

Methods of analysis

We first calculated age-standardized mortality rates by educational level, sex and year. Rates were standardized using the direct method based on the WHO standard population of 1997, which better reflects the age structure of the world population than the Segi standard population (Ahmad et al., 2001). Subsequently, we implemented separate Poisson regression models with deaths as the dependent variable and the natural log of person-years as offset variable, incorporating age and educational level as the independent variables.

To assess mortality trends by educational level, we estimated the annual percent change in mortality (APC) based on a Poisson model that incorporated an interaction between educational level and year. The APC measures the average rate of change in the mortality rate per year (Clegg et al., 2009). At a second stage, we estimated rate ratios (RR) of mortality by educational level. To assess changes in inequalities 'controlling' for changes in the educational distribution, we estimated the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII). To construct these measures, educational groups are first ordered from lowest to highest. The population in each educational level covers a range in the cumulative distribution of the population. Mortality is then regressed on the mid-point of the cumulative distribution of education for each group (Mackenbach and Kunst, 1997). The RII can be interpreted as the ratio of mortality between a hypothetical person whose relative rank in the distribution of education is zero and a person whose relative rank in the cumulative distribution of education is 100% (Mackenbach and Kunst, 1997). The SII corresponds to the equivalent absolute rate difference between these two points. Further details on the RII and SII are available elsewhere (Mackenbach and Kunst, 1997).

Regression analyses were conducted in each of the five multiple databases generated by the multiple imputation process. Since results were nearly identical for all imputations, we used the PROC MIANALYZE procedure in SAS to combine estimates from all databases and adjust standard errors, accounting for the uncertainty in the imputation (SAS Institute, 2008). This procedure reads the parameter estimates and associated covariance matrix for each imputed dataset, and then derives valid multivariate inferences for these parameters. This allows for valid statistical inference that appropriately reflects uncertainty due to missing values (SAS Institute, 2008). All analyses were conducted in SAS® version 9.2.

Results

Table 1 shows mortality rates at ages 25–64 years between 1998 and 2007 in Colombia. 633,905 deaths occurred from 1998 to 2007, with male deaths accounting for two thirds of overall deaths (66.0%), mainly owing to exceptionally high rates of homicide mortality. Non-communicable diseases accounted for half of all female mortality (50.4%) while 46.3% of mortality among men was due to injuries. Infections accounted for around 7% of deaths.

Fig. 1 shows premature mortality rates by educational level. Men and women with lower levels of education had higher premature mortality from any cause of death than their higher-educated counterparts. Rate ratios summarizing differences in mortality across educational groups are presented in Table 2. Less-educated men and women had higher rates of mortality for all causes than their higher-educated counterparts ($RR_{men} = 2.60$, 95% confidence interval [CI]: 2.56–2.64; $RR_{women} = 2.36$, 95% CI: 2.31–2.42). Inequalities were largest for injuries among men (RR = 3.64, 95% CI: 3.54–3.3), while among women, they were largest for infections (RR = 4.22, 95% CI: 3.83–4.65), particularly for tuberculosis and HIV/AIDS.

Appendix Fig. 3 shows that premature mortality declined among both men and women over the study period. However, mortality rates for those with primary and secondary education remained relatively constant or grew for deaths from infectious disease and other causes, while rates for higher educated men steadily declined for all causes. While mortality from injuries declined steadily among men with middle and higher education, it increased during the first few years for lower-educated men, and only started to decline in 2002. Fig. 2 summarizes trends in mortality differences by education on the basis of the RII. For both men and women, inequalities in total and cause-specific mortality