Cross National Comparisons of Health Disparities among Aging Populations in Latin America, the Caribbean, Asia and Africa

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Abstract

Unequal societies tend to have larger health inequalities. Conditions in low and middle income countries during the 1930s-1960s led to higher survivorship in early life due to public health interventions including medical technology but this may not have translated into parallel improvements in standard of living during childhood or throughout the life course. As a result, there may be sharper SES health disparities among these survivors of poor early life conditions. This paper examines this conjecture by matching the relative index of inequality (RII) based on education and household income with the prevalence of chronic conditions (heart disease and diabetes), functional difficulties, obesity, and poor self-reported health among older adults born during the first portion of this period using a recently compiled cross national data set of older adults from Latin America, the Caribbean, Asia, Africa, the US, England, and the Netherlands. The results in general show a positive association between the RII and the prevalence of adult health outcomes (chronic conditions, obesity, and functionality). In particular, the results for diabetes suggest the possibility of a steeper association between SES inequality in education and income and the prevalence of health outcomes among older adults in cohorts hypothesized to have a larger pool of survivors of poor early life conditions. More investigation is warranted although the conjecture regarding the long term consequences of early life conditions and later SES disparities in health among these older adults may not be totally off the mark.

Introduction

The large improvement in life expectancy during the 1930s-1960s in low and middle income countries was primarily due to reductions in infant and child mortality as a result of public health interventions including medical technology but largely in the absence of parallel improvements in standard of living (Preston, 1976; Palloni & Wyrick, 1981). For the most part, those who were exposed to poor early life conditions (e.g., poor nutrition, harsh living environments, and infectious diseases such as diarrhea, dysentery, hookworm, and malaria) in low and middle income countries during this period and then survived those conditions due to public health interventions were also poor. Higher survivorship in early life did not necessarily translate into improved standard of living during childhood or throughout the life course because of poor economic conditions or lack of social mobility (López-Alonso, 2007).

Most of the dramatic mortality decline during the 1930s-1960s occurred after 1945 (Preston, 1976) when antibiotics and other therapies appeared on the scene. It is too premature to examine adults born after 1945 because they are only now beginning to reach older ages. However, it may be possible to obtain insight by examining those born at the beginning of this period---late 1920s through early 1940s—according to the demographic changes occurring during the period.

Mortality regimes of the early to mid 20th century can be used to examine the health of these older adulgs (Palloni et al., 2007): Some countries of the developed world which experienced mortality decline during the 19th century (very early regimes); those developing countries that experienced mortality decline at the beginning of the 20th

century at higher standards of living (early regimes); those now mostly upper middle income countries which could be viewed as the precursors or "tip of the iceberg" to the dramatic decline of 1945 (mid-paced regimes); those now mostly upper middle income but larger countries which experienced rapid decline later (late) and those which experienced insubstantial changes in mortality prior to 1945 (very late). Older adults born in the mid-paced mortality regimes may be able to provide insight into the long term consequences of demographic transitions during the early to mid 20th century by comparing them with earlier and later mortality regimes.

The burden of chronic diseases, such as heart disease and diabetes, is expected to increase in low and middle income countries (Murray & Lopez, 1996). These chronic conditions may, in some instances, originate in early life (Barker, 1998). Other early life conditions are also associated with older adult mortality (Elo & Preston, 1992). Thus, if chronic conditions are increasing in low and middle income countries, if early life conditions are important to older adult health, and if some older adults born during this period are indeed more susceptible to their effects at older ages, then a comparison of health status (e.g., heart disease, diabetes, and mortality) by educational or income level should show increasingly stronger and sharper health disparities across mortality regimes most affected by the changes of the period beginning in the late 1920s and prior to 1945, controlling for confounding factors. On the other hand, other factors may have helped mediate the effects of earlier life circumstances. This paper examines this conjecture. In particular it examines the following hypothesis:

> Significant socioeconomic disparities in health status and disability of older adults in tip of the iceberg countries will be found. Keeping everything constant, social and economic disparities will be more salient in areas where the contribution of past mortality decline associated with the deployment of novel medical technology is higher. (*Adapted from Palloni et al., 2006)*

International comparisons of health disparities are difficult because of the complexities that are behind the contrasts and the existence of possible confounding factors (Wilkinson & Marmot, 2003; Banks et al., 2006; Davey Smith & Lynch, 2004). In particular: (1) Negative health gradients (i.e., higher prevalence of chronic conditions at lower educational levels) are not always the case as has been observed with the prevalence of obesity which was higher among higher educational levels in pre-health transition, low income countries (Monteiro, Conde, Lu, & Popkin, 2004). It may also be that this phenomenon blurs the difference between socioeconomic (SES) levels within countries which show an uneven progress in the health transition. In addition, puzzling and unexpected patterns of health disparities have appeared in some middle income countries (Rosero-Bixby & Dow, 2009). (2) Other mechanisms such as improved health care systems or changes in health behavior may also affect health. Such might be the case in a country such as Costa Rica which has an exemplary primary health care system. (3) Those with better socioeconomic conditions may live longer and thus as a group may naturally exhibit a higher prevalence of chronic conditions or frailty. Such might be the case in higher income countries where life has been prolonged by advances in medical technology. Contrasts between higher and lower educational or income levels in these cases may be attenuated, blurring the effects of poor early life conditions. (4) Unequal societies in general have a more negative impact on health (Wilkinson, 1996) and thus distinguishing the effects of poor early life conditions may be challenging at best.

Nevertheless, the following two broad regularities are expected in a comparison of older adult health (heart disease, diabetes, and mortality) across countries and mortality regimes of the early to mid 20th century: (1) a general pattern of steep health disparities

in the mid-paced mortality regimes most affected by mortality changes prior to 1945; but (2) a reversal of the health gradient for chronic conditions in some instances in mortality regimes which experienced minor mortality changes before 1945. A comparison within and across countries should also reveal the following patterns: (1) overall cross national pattern of steeper SES health disparities in the mid-paced to late regimes; (2) steeper health disparities in early regimes such as Argentina and Uruguay as compared with Cuba which experienced a very different approach to health care; (3) steeper health disparities within mid-paced regimes such as Puerto Rico and Chile as compared with other mid-paced regimes which have either quality primary health care systems (Costa Rica) or which experienced large economic improvements in the 20th century (Taiwan); or (4) steeper health disparities within late to very late regimes such as Bangladesh, Indonesia and India in comparison with China which implemented a different institutional framework for health care.

Methods

Data

Survey data come from a newly compiled cross national data set of low, middle and high income countries. The data are drawn from comprehensive and representative surveys of older adults or household surveys at either the national, regional or major city level. From Latin America there are the Mexican Health and Aging Study (**MHAS**, first wave, n=13,463), Puerto Rican Elderly: Health Conditions (**PREHCO**, first wave, n=4,291), Study of Aging Survey on Health and Well Being of Elders (**SABE**, n=10,597) and Costa Rican Study of Longevity and Healthy Aging (**CRELES**, first wave, n=2,827). From Asia there are the China Health and Nutrition Study (**CHNS**, n=6,452), Chinese Longitudinal Healthy Longevity Survey (**CLHLS**, n=16,064), WHO Study on Global

Ageing and Adult Health Study in China (**WHO-SAGE,** n=12,284), Indonesia Family Life Survey (**IFLS**, wave 2000, n=13,260), the Bangladesh Matlab Health and Socio-Economic Survey (**MHSS**, n= 3,721), WHO Study on Global Ageing and Adult Health Study in India (**WHO-SAGE**, first wave, n=6,559) and Social Environment and Biomarkers of Aging Study in Taiwan (**SEBAS**, n=1,023). From Africa there are the WHO Study on Global Ageing and Adult Health Survey in Ghana (**WHO-SAGE**, n=4,302) and South Africa (**WHO-SAGE**, first wave, n=3,830). From the developed world there are the Health and Retirement Study (**HRS**, wave 2000, n=12,527), Wisconsin Longitudinal Study (**WLS**, wave 2004, n=10,317), English Longitudinal Study of Ageing (**ELSA**, second wave, n=8,780) and Survey of Health, Ageing and Retirement-Netherlands (**SHARE-Netherlands**, first wave, n= 2,979).

Measures

Mortality regimes.—The paper uses a classification of countries developed to reflect mortality regimes of the early to mid 20th century according to the speed and timing of mortality decline and according to the degree to which mortality decline was due to the implementation of public health interventions and medical technology or to improvements in standard of living (McEniry, 2009). These include: (A) very early mortality decline (e.g., Netherlands, England, and US); (B) early, graded mortality decline (e.g., Argentina and Uruguay); (C) early, less graded, mid-paced mortality decline (e.g., Chile, Costa Rica, Puerto Rico, and Taiwan); (D) late, rapid mortality decline (e.g., Barbados, Mexico, and Brazil); and (E) little or no mortality decline prior to 1950 (e.g., Bangladesh, China, Indonesia, India, and Ghana).

Older adults born in C and to some extent D regimes prior to 1945 represent the first of a burgeoning wave of adults who have increasingly survived poor early life conditions

due to reduction in disease but who nevertheless continued to be exposed to poor economic conditions. The now mostly upper-middle-income countries in which these older adults were born during the late 1920s through early 1940s could be considered tip of the iceberg countries because of this growing elderly population. Previous work set the foundation for developing the concept of tip of the iceberg countries (Palloni et al., 2006). The tip of the iceberg countries included:

- Smaller and poor developing countries that were able to implement widespread reforms in public health prior to 1945 amidst stagnant economic conditions (e.g., Puerto Rico, Costa Rica, and Chile);
- Urban areas in some larger poor developing countries which began to experience significant mortality decline prior to 1945 (e.g., Mexico and Brazil).

Adult SES.— Years of education and per capita household income were obtained from information provided by older adult respondents. Levels of education are defined according to the number of years of education and using United Nations' standards for low to middle income countries: no schooling; primary (1-6 years of education); and secondary and above (7 years and above). Three levels of education are defined because, for the most part, many countries had a very small number of respondents with greater than 12 years of education. In the case of the US, UK, and Netherlands, three levels were used according to what has been suggested by others for high income countries (Banks et al., 2006): low (0-12 years of education); middle (13-15 years); and high (16 and above years). Household income was previously estimated either by the country-specific survey or by the author for each country and per capita household income computed according to household size (McEniry, 2010b).

Demographic and adult lifestyle.—Age and gender were used in basic multivariate models.

Adult health.— Elderly adult health was defined by dichotomous variables using self-reported heart disease and self-reported diabetes. The self-reports are based on questions asked of the respondent about whether a doctor had ever diagnosed them with heart disease or diabetes. In the SAGE data, there were questions asked of the respondent which captured symptoms for heart disease (angina) based on the Rose questionnaire (Rose, 1962; Rose et al., 1977) and these questions are used to arrive at prevalence rates for heart disease. Obesity was calculated using body mass index (BMI) based on height and weight measurements (BMI greater than or equal to 30). A harmonized measure of difficulties with activities of daily living (ADLs) and poor self-reported health were also used as adult health outcomes (McEniry, Moen, & McDermott, 2013). Although self-reported health may be problematic in cross national comparisons, it is also true that self-reported health is strongly associated with mortality. Given that several countries did not have mortality data, a dichotomized variable was created as a proxy for mortality to indicate if the respondent had self-identified as having the worst category of health.

Sample

Older adults born during the late 1930s through early 1940s were selected as part of the analysis. While these adults represent different mortality regimes of the 20th century, of particular interest are those older adults born in mortality regimes which began to experience more rapid decline in mortality during the 1930s-1960s, primarily due to public health interventions and medical innovation. In this paper, these mortality regimes are referred to as "tip of the iceberg" because they represent the first

wave of older adults who increasingly survived poor early life conditions amidst stagnant economic conditions.

Analysis

Previous analyses were conducted using several different health outcomes with education, per capita household income and wealth (McEniry, 2010a). Basic comparisons between low/high education (income) using ratios and multivariate models produced weak evidence that older adults born in the tip of the iceberg countries in the late 1920s through early 1940s were any different or worse in terms of health disparities than other older adults born in other countries examined.

This paper attempts to further previous analyses by using a measure of inequality that may be more suited to cross national comparisons and large differences between population sizes and distributions of education and income across selected countries. This summary measure of inequality--the relative index of inequality (RII)--was constructed by ranking the years of education (income or wealth) and then creating a variable which is the ratio of the ranking against the population size (Mackenbach & Kunst, 1997; Kakwani, Wagstaff, & van Doorslaer, 1997).

The analysis began with a description of the prevalence of chronic conditions and other health conditions across different levels of education and income. The distribution of education and income across countries is then examined to show variation across countries. The RII was then used to estimate the effects of inequality from education (income) on adult heart disease, diabetes, obesity, poor self-reported health, and having at least one difficulty in functionality using basic age- and gender-adjusted regression models. Imputation methods (Raghunathan, Reiter, & Rubin, 2003) were used in previous analyses to address missing values in income and

education variables and similar results were produced using non-imputed data. In this paper, results are presented for non-imputed data.

Results

Sample and country characteristics

The overall picture obtained of the older adult population born in the late 1920s through early 1940s across a diverse range of countries using surveys of older adults presents few surprises (Table 1). The majority of the respondents are female. The pattern in poorer countries was of lower educational attainment, lower income, and a higher percentage born in rural areas. From previous analyses not shown in the table we also know that respondents in the poorer countries have shorter height, higher percent underweight, lower parental education, and a large percentage saying they experienced poor SES and health and were hungry as children. The percent of respondents saying that they have smoked was smaller in many of the poorer countries. There was a higher prevalence of chronic conditions and obesity, especially in the Latin American and Caribbean countries, in contrast to some countries of Asia where being underweight was more of a problem than obesity. The majority of the respondents said that they had visited a medical professional at least once in the last 12 months. Not surprisingly both education and household income in some countries had a high percent of missing values.

There were large expected differences in the distribution of education and income across developed and developing countries. The distribution of education is markedly different in the developed and developing world and thus Figure 1 splits the two groups of countries showing slightly different definitions for low, middle and high education. A majority of respondents in England, the US and the Netherlands reported having only

12 years of education (defined as low). The percent of older adults with no formal education increased in countries such as China, India, Bangladesh, and Indonesia; this was especially true for women (results not shown). A comparison with median household income between the developed and developing world also produces large differences (Figure 2).

Table 2 shows the countries studied in terms of national income along with recent information regarding health care, life expectancy at age 60, human development and the Gini index (a measure of inequality). On the surface the table suggests that several of the selected poor developing countries of the early- to mid-20th century have made improvements and are now middle income countries of the 21st century. GDP per capita has improved for the countries that were poorer in the 1930s; although income inequalities still exist, many are now upper-middle-income countries. A few (Costa Rica, Cuba, and Chile) have a similar rating for their health care system as the US, and a few (Costa Rica, Cuba, and Mexico) have life expectancy at age 60 close to that of the US. The countries with the highest levels of inequalities are Puerto Rico, Argentina, Mexico, Chile, South Africa, and Brazil.

[Insert Tables 1 & 2 and Figures 1-2 about here]

SES health disparities

For respondents born in the late 1920s and early 1940s, the pattern of self-reported heart disease by educational level was mixed both within and across countries (Figure 3). For the most part (except in Indonesia, Brazil, and China), the gradient was in the expected direction for females—higher prevalence of heart disease at lower educational

levels in earlier regimes—but not in the expected direction for males for whom in many countries and different mortality regimes (Indonesia, China, Barbados, Netherlands, Mexico, Brazil, Argentina) there was a reversal of expected patterns—those with more education show a higher prevalence of heart disease.

With the exception of Chile and India, the countries with the highest proportion reporting heart disease tended to be mostly from the very early or early mortality regimes with the exception of India in the case of females. The countries with the lowest proportion reporting heart disease tended to be very late mortality regimes (China, Indonesia). Within countries, the greatest differences in heart disease between the lowest and highest level of education tended to be seen in Argentina, Uruguay, and Puerto Rico. The gap in prevalence of heart disease between low and high education levels appeared larger in females than it does in males in several instances.

For diabetes, a clearer pattern emerges (Figure 4). For the most part, the gradient was in the expected direction for females—higher prevalence of diabetes at lower educational levels in earlier regimes, with the exception of the very late regimes of Indonesia, Ghana, China, India, and Bangladesh where, as expected (Monteiro, Conde, Lu, & Popkin, 2004) there was a clear reversal of the gradient; exceptions were South Africa and Cuba. For males, the reverse of what is expected occurs in Cuba, Chile, and Brazil; exceptions are found in the mid-paced mortality regimes of Chile and Brazil and Mexico, Costa Rica and Barbados. A higher prevalence of diabetes appears in the mid-paced mortality regimes of Puerto Rico, Mexico, Costa Rica and the late regime of Barbados. The lowest prevalence appears in the very late regimes of China, Ghana, and Indonesia. Overall, very large educational disparities appeared in Barbados and Mexico

for males and in the early regimes of Argentina and Uruguay and later regimes of Taiwan, Barbados, Mexico, and Costa Rica for females.

The patterns for obesity, a risk factor for heart disease and diabetes, showed disparities but no very large disparities and an expected gradient in most countries (Figure 5). The countries showing a higher proportion of obese are the developed countries but also appearing are other middle income countries. A higher proportion of obese adult are found in the US, South Africa and England among males and South Africa, Uruguay and Mexico among females. Larger gaps between low and high education levels appear in males in Mexico, Puerto Rico, Uruguay and in females for Barbados and Uruguay. There are reversals that appear for Barbados, Costa Rica, Mexico and South Africa for males and Ghana, Indonesia, India, China, South Africa for females.

A very clear pattern of disparities emerged when examining functionality where large disparities between education level appear but there was no reversal of the gradient (Figure 6). The higher proportion of older adults with difficulties in functionality appears in the late regimes of Ghana and India and the mid-paced regimes of South Africa for males and India, Ghana and Mexico for females. The lower proportion appears for Taiwan, Netherlands, China for both males and females. A similar pattern appeared for poor self-reported health (Figure 7). A higher proportion of respondents reported worse health in the Latin American regions for both males and females.

Similar patterns appeared using income but the results are not presented here for reasons of space.

[Insert Figures 3-7 about here]

RII predicting adult health outcomes

Table 3 shows the odds ratios of the relative index of inequality (RII) for education and corresponding significance levels for different adult health outcomes using models adjusted for age and gender. Of particular note are the consistently strong and significant RII effects for obesity, poor health and functionality. In contrast, the results are mixed for adult heart disease and diabetes the results. Strong positive associations between being in the lower portion of the distribution of education and the likelihood of reporting heart disease and diabetes appears in the very early regimes and the reverse for the very late regimes but in only a few countries in the other regimes. The corresponding results for income show similar patterns (Table 4).

[Insert Tables 3 &4 about here]

Matching RII with health outcomes

When the RII was compared against several different health outcomes it was generally true that a higher RII is associated with higher prevalence of health conditions. In the case of adult heart disease (Figure 8) there was a positive association between RII and adult heart disease. Two lines of association are drawn through the points in the graph and there appears to be a no clear difference between the developed countries and the mid-paced or very late regimes. Both exhibit high inequalities. The pattern of a positive association between inequality and the prevalence of heart disease using income is slightly clearer. In contrast, the pattern is clearer and interesting for adult diabetes (Figure 9). There is a positive association between RII and adult diabetes and the very early regimes (US, Netherlands, England), the mid-paced (e.g. Costa Rica,

Puerto Rico) and late regimes (e.g. Mexico, Brazil) all exhibit high inequalities. However, the later two regimes also show a higher prevalence of diabetes. Fitting a line through the mid-paced and late regimes produces a steeper line of association. A similar pattern emerges when examining income.

The pattern with obesity is not as clear as it was with diabetes (Figure 10). There are almost two notable patterns---the very late regimes which show almost no association with health and inequality and the remaining countries which show the same positive association as noted with heart disease and diabetes and which also show the same difference between the very early regimes and the mid-paced to late regimes (suggesting a steeper line of association in the later two regimes).

Although the pattern of inequality was consistent across countries for both functionality and self-reported health and although there was a consistent very strong country-specific association between the RII and health, the emerging cross national pattern shows an association between functionality and RII (Figure 11) but not with poor self-reported health (Figure 12). The plotted line does not show any particular pattern of steeper SES disparities that distinguish the mid-paced to late regimes.

[Insert Figures 8-12 about here]

Discussion

The relative index of inequality was used to examine health inequalities of older adults born during the late 1920s through early 1940s, particularly among those older adults born in poor countries of the 20th century that were beginning to experience significant improvements in mortality at early ages but in the context of stagnant

economic conditions. Overall, the findings showed strong health inequalities across countries and large within-country variation. There was a general positive association between inequality and the prevalence of selected chronic conditions, obesity and functionality. The results for diabetes suggest the possibility of a steeper association between inequality in education and income and the prevalence of certain health outcomes for the mid-paced and late regimes (tip of the iceberg). However, there were an insufficient number of significant coefficients for RII to be able to make a better discernment of the cross national pattern in the case of diabetes. There was also no clear pattern of disparities across health outcomes within mortality regimes.

The overall conclusion of a positive association between SES inequality and the prevalence of health outcomes supports the general idea that unequal societies have a more negative impact on health (Wilkinson, 1996). The lack of an association between RII and poor self-reported health is not surprising; cross national comparisons of self-reported health can be difficult to interpret because of cultural differences in interpretation of scales and questions. Although the evidence is weak in regards to a steeper association in the association between inequality and health outcomes for the unique cohorts of the late 1920s through early 1940s, the results for diabetes in particular suggests that the conjecture may not be totally off the mark.

However, it is important to point out that the distribution of education is very different between the developed and developing world. Thus, using RII cross national comparisons between the two regions as depicted in the graphs should be approached with caution. Although the patterns noted in the results remains essentially the same, it is also important to point out that the graphs matching RII with health include RII odds ratios some of which were not significant in models.

The reversal of patterns noted in the results could reflect development levels. A reversal in the pattern in obesity (i.e. better off were more obese) was noted in countries at lower economic development; the patterns reversed (i.e. less well off were more obese) as economic development improved (Monteiro et al., 2004). Obesity (which is measured) along with heart disease and diabetes (self-reported) showed some reversal of the expected Western pattern suggesting that development level may partially explain the reversal pattern.

Underestimation of adult heart disease and diabetes may also partially explain the results. The reversal of patterns could reflect the underestimation of chronic conditions and that people who do not have access to good quality care (or do not use it) may not know of their health condition. Previous analyses of the impact of underestimation of adult heart disease and diabetes showed that underestimation produce similar direction of associations but the magnitude may be very different (McEniry, in press). If this is the case, then underestimation may indeed be problematic in properly discerning differences in cross-national patterns based on the magnitude of the coefficients. The answer may lie with both underestimation and development stages.

Social mobility may also be an important factor and partially explain the results; the economic circumstances of individuals may have improved, making differences hard to discern. In spite of the high levels of inequality experienced in these mid-mortality regimes during the 20th century, it may be there was sufficient social mobility among those born poor to offset steeper health gradients at older ages. This could have occurred in Puerto Rico where those born poor in urban areas fared better as adults than those born poor in rural areas where conditions were more precarious during the 1930s-1940s. It also could have occurred because migration to the US may have

sufficiently improved economic conditions regardless of poverty status during childhood (in the case of Puerto Rico or Mexico). It could also be due to remittances from those who migrated to the US (in the case of Mexico). Finally, it may have occurred due to dramatic economic growth in the 1950s which set countries such as Taiwan on a path to much higher standards of living. If social mobility explains the results then the findings reject the idea of health selection for the unique cohorts of the 1930s-1960s—i.e., that the increasing number of survivors in the tip of the iceberg countries would lead to a larger pool of adults with lower adult SES.

There are several other possible explanations for the weak evidence regarding sharper health disparities among the unique cohorts of the 1930s-1960s. The health gradient in low- and middle-income countries is complex and conflicting results have emerged (Rosero-Bixby & Dow, 2009). The analysis may be at too aggregate of a level to understand the underlying associations between inequality and prevalence of heart conditions. For one, the analysis combines those born in rural and urban areas which may be an important distinction because for the most part in the developing world conditions were more precarious in rural areas. Country heterogeneity makes it difficult to really conduct these cross country comparisons. The categorization of the countries is also broad. Older adults in the tip of the iceberg countries are not homogenous in terms of the mortality regime they experienced. In the case of Puerto Rico, although mortality in general was declining during the late 1920s through early 1940s, there were regions within the country where high infant and child mortality still prevailed. This may produce results that are hard to interpret. Selection may be an issue. At older ages, the health gradient begins to disappear because of selection effects (Smith, 2005). It may be

that SES differentials in the mid-mortality regimes have weakened for this age group due to mortality selection.

The nature of the data and the measures used may contribute to uncertainty. If it were possible to identify a larger pool of survivors of early conditions, then it would be possible to be more precise about comparisons, but the sample size for those born during the late 1920s and early 1940s in some countries is small. The SABE survey was conducted in major cities rather than the entire country, so it is not nationally representative. It may be that the smaller sample size in some countries is responsible for some of the large variation observed. Analyses with income were conducted (results not shown), but income is also notoriously error prone with large proportions of missing data. It may not be possible to capture the complexity of the health gradient with these measures. There may be specific national circumstances among countries in the mid-mortality regimes; this may be more of a country by country story rather than a pattern across countries. It may be too early to observe the pattern of health disparities in older adults born prior to 1945 and the 1950s when mortality declined more dramatically.

It may also be, of course, that the premise on which the conjecture is based is not valid. That is, it may be that the relative importance of early life conditions on older adult health is smaller than anticipated. It may be that health selection in early life plays a smaller, although perhaps non-trivial, role for the unique cohorts of the 1930s-1960s, (Palloni et al., 2009) and that the analyses of health disparities presented here were not able to adequately capture this.

Forecasts show a rising tide of older adults with an increasing prevalence of chronic conditions across the world (Murray et al., 2012; Lim et al., 2012; Yan et al., 2012). The early life conditions of some of these older adults were marked by poor nutritional

conditions who survived infant and childhood diseases due to better medical and public health interventions, and some of these adults may have poor diets and/or be smokers. The relative importance of early life factors or other factors across the life course as determinants of older adult health such as heart disease and diabetes is not yet clear for the entire membership of the unique cohorts of the 1930s-1960s. It is not yet clear whether the survivors of infant and childhood diseases due to circumstances in the 1930s-1960s will also translate into a tide of adults with poor health at older ages or whether this tide will be reduced to a trickle or small flow because of better conditions later in life.

The data have their limitation but this is the kind of work that is possible now with the available data and it is hoped that this work will motivate future work. The ambitious effort to compile and collect data to examine a conjecture with important ramifications if proven to have merit has thus not been in vain; it has provided a baseline glimpse into the unique cohorts of the 1930s-1960s. The data do not dismiss the possibility that rapid mortality transitions in early life in poor countries without parallel economic growth and then later rapid changes in adult diet may be a deadly combination for older adult health. As surveys of older adults incorporate more biomarkers to obtain a better sense of adult health status and as relevant administrative and historical data become available it will be possible to further examine the contrarian conjecture—a conjecture that warrants further examination. The conjecture is of importance and relevance to older adult health because it presents a historical and macro explanation of the determinants of older adult health in some settings which has not yet been fully explored. A careful examination of the unique cohorts of the 1930s-1960s has the potential for guiding future policy to improve people's lives.

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Table 1: Sample characteristics for cross national data on aging populations born during the late 1920s-early 1940s in selected low and middle income countries

Regime/ Country	F (%)	Age	School Years	Born rural (%)	Ever smoked (%)	Obese (%)	Limited function (%)	Poor health (%)	Diabetes (%)	Heart Disease (%)	Visited doctor (%)
Early											
Cuba	55	66 (4)	8 (4)	52	58	17	11	63	14	23	72
Uruguay	63	67 (4)	6 (4)	41	46	34	12	38	14	20	74
Mid-Paced											
Chile	58	66 (4)	7 (5)	47	51	34	16	60	14	31	72
Costa Rica	52	68 (5)	5 (4)	72	43	25	11	47	22	11	93
Puerto Rico	55	67 (5)	9 (5)	57	33	30	9	66	28	16	86
South Africa	64	69 (6)	6 (5)	38	33	44	27	19	13	10	70
Taiwan	42	67 (5)	5 (4)	--	23	8	4	28	16	16	38
Late											
Barbados	59	67 (4)	6 (4)	47	26	29	5	42	22	9	90
Brazil	59	66 (4)	4 (3)	64	49	23	14	53	18	18	84
Mexico MHAS	52	63 (5)	4 (4)	65	40	20	5	63	17	3	60
Mexico SABE	55	66 (4)	5 (5)	54	47	32	12	71	21	9	79
Mexico SAGE	53	72 (6)	4 (4)	32	41	27	22	13	19	12	40
Very Late											
Bangladesh	54	59 (6)	2 (3)	99	30	1	12	34	15	--	68
China SAGE	54	70 (5)	5 (5)	55	34	6	7	29	8	12	60
Ghana	50	70 (5)	3 (5)	60	25	8	27	21	5	14	68
India	48	69 (5)	3 (4)	73	58	2	32	28	6	22	89
Indonesia	54	62 (5)	4 (4)	84	50	3	6	22	3	4	10

Source: RELATE data (2013), weighted where relevant. Omitted from the table are the very early regime countries of the US, England, and the Netherlands. Also omitted are countries which did not measure obesity (Argentina and China-

CLHLS) and for which information on rural/urban birthplace were not available (Taiwan and China-CHNS). Russia is omitted because it has a more complex history of mortality decline during the early to mid 20th century. The values above are based on a total sample of 27,105 respondents. Sample sizes for individual countries were: Cuba (1,007), Uruguay (810), Chile (704), Costa Rica (1,522), Puerto Rico (2,395), South Africa (1,068), Taiwan (546), Barbados (735), Brazil (868), Mexico-MHAS (2,200), Mexico-SABE (727), Mexico-SAGE (938), Bangladesh (2,242), China-SAGE (4,231), Ghana (1,721), India (2,399), and Indonesia (3,538).

Notes: All numbers are either percentages (where indicated) or averages with standard deviations in parentheses. "F" refers to female. Age is at the time of the surveys. Respondents from Bangladesh are slightly younger and respondents from SAGE are slightly older than other older adult respondents due to timing of the surveys. Limited function is having difficulty with at least one activity of daily living. This measure has been harmonized across countries. Poor health is poor self-reported health. This measure was also harmonized across countries. Visited doctor reflects if respondent had visited a doctor or similar medical professional at least once within the last year. This measure was also harmonized although the question in the Indonesian survey reflects a 5-year period. The averages appearing for diabetes and heart disease are age-standardized and are shown in Figures 1 and 2. Education and household income were the two major variables where missing values made up greater than 5% of the data for those born prior to 1945. Missing values for education ranged from 6% in Mexico-SAGE and Taiwan to 17% in South Africa. Missing values for household income ranged from 6% in China-SAGE to 33% in the Russian Federation which is not shown in the table.

Table 2: Income, health care rating, life expectancy, human development and inequality in selected countries

	Income Group	Health Care Rating	Life Expectancy at Age 60 (M, F)	Human Devpmt Ranking	Gini Index
Country	**2000**	**2000**	**2000**	**2000**	**1995-2005**
Barbados	High	46	18.6, 22.6	31	39
England	High	18	18.8, 22.7	13	36
Netherlands	High	17	18.9, 23.7	8	31
Puerto Rico	High	37	19.6, 23.1	---	56
Taiwan	High	---	20.0, 22.9	---	33
US	High	37	19.6, 23.1	6	41
Argentina	Upper middle	75	17.8, 22.8	34	53
Brazil	Upper middle	125	16.2, 19.6	73	59
Chile	Upper middle	33	18.3, 22.7	38	55
Costa Rica	Upper middle	36	19.3, 22.8	43	47
Cuba	Upper middle	39	19.3, 21.5	55	41
Mexico	Upper middle	61	19.7, 21.7	54	53
South Africa	Upper middle	175	14.5, 17.1	107	58
Uruguay	Upper middle	65	17.1, 22.2	40	45
China	Lower middle	144	16.6, 20.4	96	42
India	Lower middle	112	14.6, 17.7	124	37
Indonesia	Lower middle	92	15.5, 17.5	110	38
Bangladesh	Low	88	14.7, 15.7	145	31
Ghana	Low	135	14.5, 16.5	129	41

Sources: Maddison, 2006, 1990 international dollars; WHO, 2000, 2002; World Bank, 2011; United Nations Development Program, 2002; World Bank, 2012; and FAO Statistics Division, 2010. The values displayed in the table are the closest available Gini indices to the year 2000. The values come from the World Bank (2012) with the exception of Barbados (John & Firth, 2005), Cuba (Ranis & Kosack, 2004), Puerto Rico (Toro, 2008), and Taiwan (CIA, 2012).

Notes: Countries are alphabetized within income group. Bangladesh was part of India until 1947. Lower numbers for health care are better.

Table 3: Effects of relative index of inequality for education on adult health

	Health Outcome				
Regime/country	**Heart Disease**	**Diabetes**	**Obesity**	**Poor Health**	**Difficulty with at least one ADL**
Very early					
Netherlands (2,922)	1.91*	2.54*	2.62***	2.03**	1.82
England (8,006)	1.30	1.98	4.53***	20.03***	5.65***
US-HRS (12,506)	1.52***	2.83***	1.95***	10.51***	4.78***
US-WLS (7,265)	2.12***	6.47***	4.04***	9.02***	--
Early					
Argentina (1,040)	1.15	5.35***	--	9.74***	4.13***
Cuba (1,895)	0.98	0.65	0.85	2.24***	2.71**
Uruguay (1,424)	1.29	2.34*	2.46***	3.01***	2.33*
Mid-paced					
Chile (1,244)	1.24	0.83	1.87*	3.34***	4.11***
Costa Rica (2,803)	1.59	1.40	0.62*	4.57***	2.05**
Puerto Rico (4,245)	1.65**	1.46**	1.06	4.25***	2.57***
South Africa (3,151)	2.74*	0.20***	0.28***	4.75***	1.66
Taiwan (963)	1.06	1.71	2.72	4.73***	9.96*
Late					
Barbados (1,495)	1.11	1.32	1.02	2.27***	1.13
Brazil (2,120)	1.29	1.20	0.93	4.37***	1.98*
Mexico-MHAS (13,445)	0.57*	1.06	1.30*	4.72***	2.78***
Mexico-SABE (1,234)	0.90	3.97***	1.55	5.58***	7.75***
Mexico-SAGE (2,014)	1.28	0.89	0.47**	2.87**	2.13**
Russia-SAGE (3,929)	0.59**	0.96	1.46	2.87***	2.58***
Very Late					
Bangladesh (6,183)	--	1.09	5.82	4.17***	2.84
China-CHNS (5,608)	4.74	0.31	0.18**	1.83*	2.68*
China-CLHLS (15,959)	0.17***	0.12***	--	2.88***	0.82
China-SAGE (13,262)	0.28***	0.16***	0.98	4.99***	3.02***
Ghana (4,281)	37.10***	0.003***	0.02***	0.97	1.30
India (6,560)	2.46*	0.01***	0.05***	6.29***	6.54***
Indonesia (10,155)	0.13***	0.05***	0.08***	1.07	0.69

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Source: RELATE data (2013). Shown in the table are country-specific models using the RII for education.

Notes: Models controlled for age and gender. Sample sizes are shown in parentheses in table. Numbers greater than one in the table indicate a strong positive association between being in the lower portion of the distribution of education and a particular health outcome.

Table 4: Effects of relative index of inequality using income on adult health

	Health Outcome				
Regime/country	**Heart Disease**	**Diabetes**	**Obesity**	**Poor Health**	**Difficulty with at least one ADL**
Very early					
Netherlands (2,979)	1.99*	1.47	1.40	1.44	0.83
England (8,647)	1.29*	1.65**	1.79***	2.86***	1.61***
US-HRS (11,603)	1.96***	4.36***	2.24***	13.55***	10.31***
US-WLS (7,186)	1.22	1.92***	1.55***	3.62***	--
Early					
Argentina (969)	1.38	2.06	--	3.74***	1.11
Cuba (1,904)	1.33	1.07	0.57	1.45	1.67
Uruguay (1,333)	1.22	2.07	1.29	3.50***	2.27*
Mid-paced					
Chile (1,271)	0.87	1.12	1.01	3.01***	3.54***
Costa Rica (2,443)	1.20	0.91	0.70	5.92***	3.55***
Puerto Rico (4,059)	1.54*	1.19	0.88	2.72***	2.02***
South Africa (3,009)	1.33	0.52*	1.09	1.39	1.37
Late					
Barbados (1,258)	0.88	2.18*	1.61	1.29	1.43
Brazil (2,143)	0.90	0.95	0.87	2.53***	2.06*
Mexico-MHAS (13,411)	0.72	1.11	0.69***	2.74***	2.39***
Mexico-SABE (1,247)	0.78	1.15	2.73**	4.16***	2.56*
Mexico-SAGE (2,246)	1.39	0.84	0.51*	1.31	2.00**
Russia-SAGE (3,045)	0.62*	0.58	0.68	2.19***	1.52
Very Late					
Bangladesh (6,944)	--	1.49*	4.14	1.18	1.00
China-CHNS (6,324)	1.18	0.33**	0.34**	1.42*	3.46***
China-CLHLS (15,294)	0.23***	0.21***	--	2.88***	0.53*
China-SAGE (12,671)	0.63**	0.13***	0.67	5.01***	3.43***
Ghana (3,318)	1.14	0.29**	0.59	1.99**	0.93
India (7,028)	1.59**	0.22***	0.42*	2.55***	3.06***
Indonesia (11,644)	0.33**	0.18***	0.17***	1.27	1.10

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Source: RELATE data (2013).

Notes: Models controlled for age and gender. Sample sizes are shown in parentheses in table. There is no income data available for Taiwan. Numbers greater than one in the table indicate a strong positive association between being in the lower portion of the distribution of education and a particular health outcome.

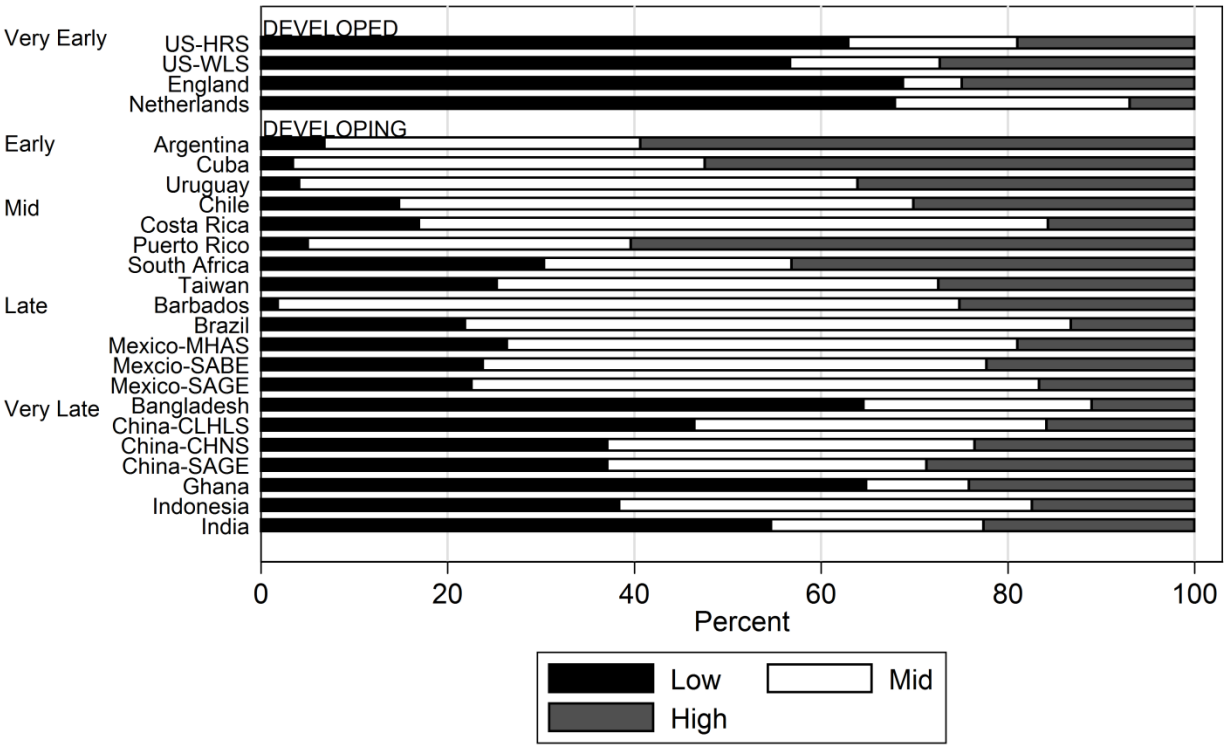

Figure 1: Distribution of education across countries

Source: RELATE data (2013). Russia is not shown because it was excluded from analyses.

Notes:

For developing countries, low = no school, mid = primary school, and high = secondary school or more; for developed countries, low = 0-12 years of education, mid = 13-15 years of education and high = 16 or more years of education.

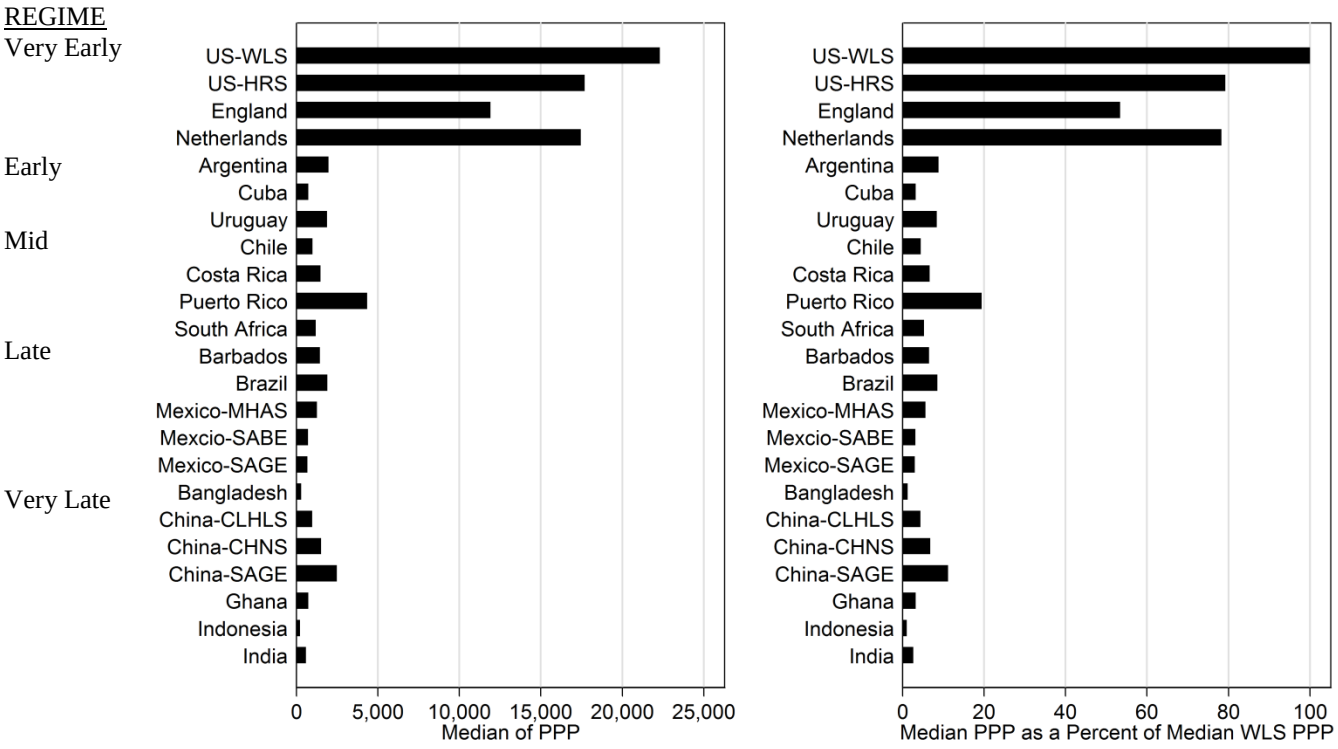

Figure 2: Cross national comparison of per capita household income as expressed in purchasing power parity (PPP)

Source: RELATE data (2013). Russia is not shown because it was excluded from analyses.

Notes: The median per capita household income expressed in purchasing power parity (PPP) international dollars for the year 2000. The second portion of the graph shows a comparison with the US-WLS. For example, the household income of respondents from the Netherlands was about 80% that of the income from WLS respondents.

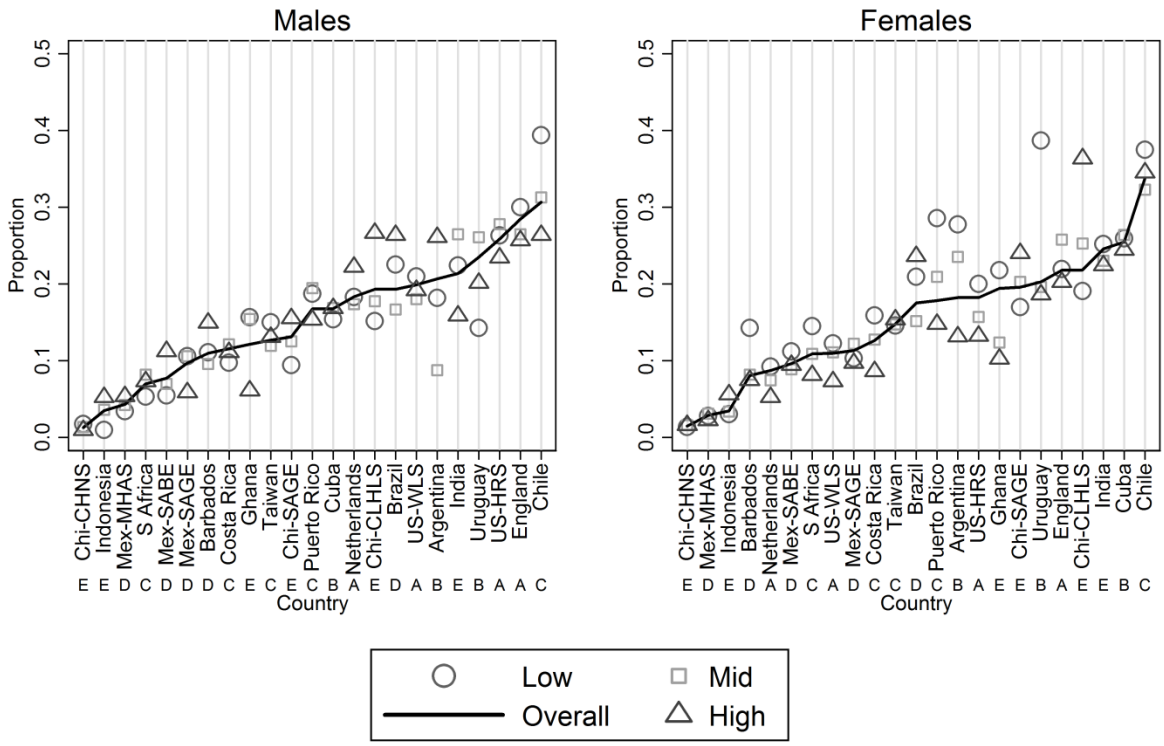

Figure 3: Prevalence of heart disease by level of education

Source: RELATE data (2013).

Notes:

For developing countries, low = no school, mid = primary school, and high = secondary school or more; for developed countries, low = 0-12 years of education, mid = 13-15 years of education and high = 16 or more years of education.

Mortality regimes and corresponding countries:

A. Very early: England, Netherlands, US-HRS, US-WLS
B. Early: Argentina, Cuba, Uruguay
C. Mid: Chile, Costa Rica, Puerto Rico, Taiwan, South Africa
D. Late: Barbados, Brazil, Mexico-MHAS, Mexico-SABE.
E. Very Late: China-CHNS, China-CLHLS, China-SAGE, India, Indonesia, Ghana

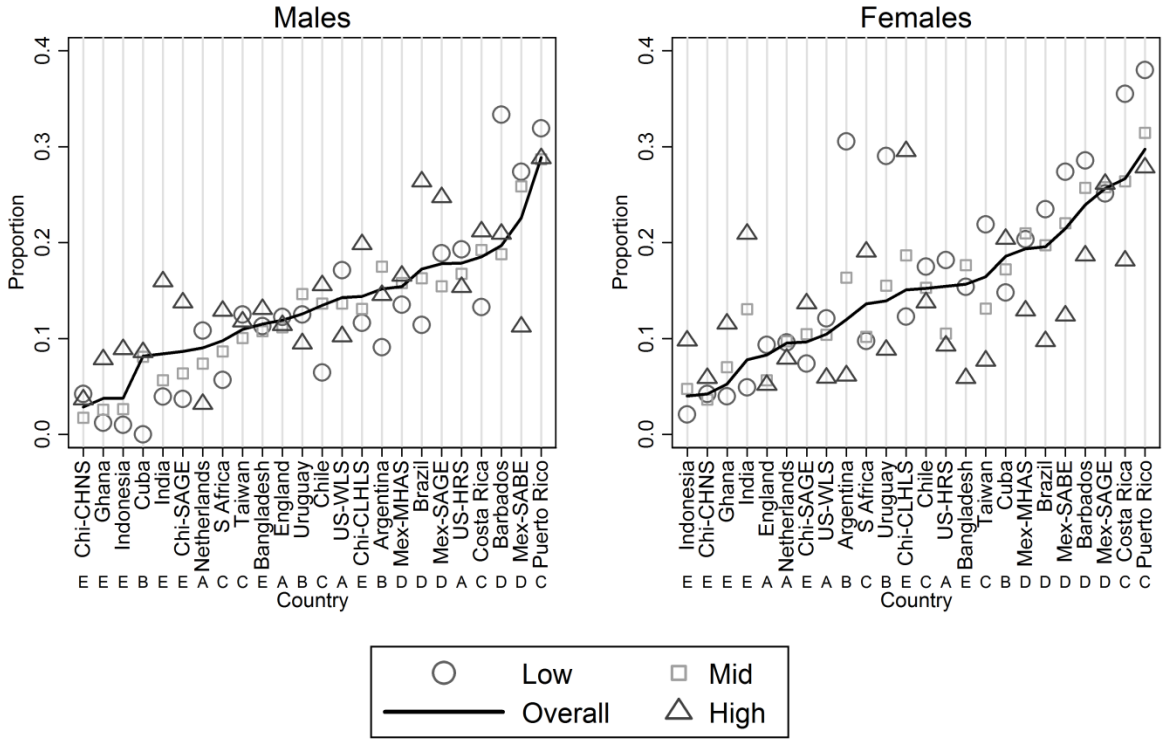

Figure 4: Prevalence of diabetes by level of education

Source: RELATE data (2013).

Notes:

For developing countries, low = no school, mid = primary school, and high = secondary school or more; for developed countries, low = 0-12 years of education, mid = 13-15 years of education and high = 16 or more years of education.

Mortality regimes and corresponding countries:

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D. Late: Barbados, Brazil, Mexico-MHAS, Mexico-SABE.
E. Very Late: China-CHNS, China-CLHLS, China-SAGE, India, Indonesia, Ghana

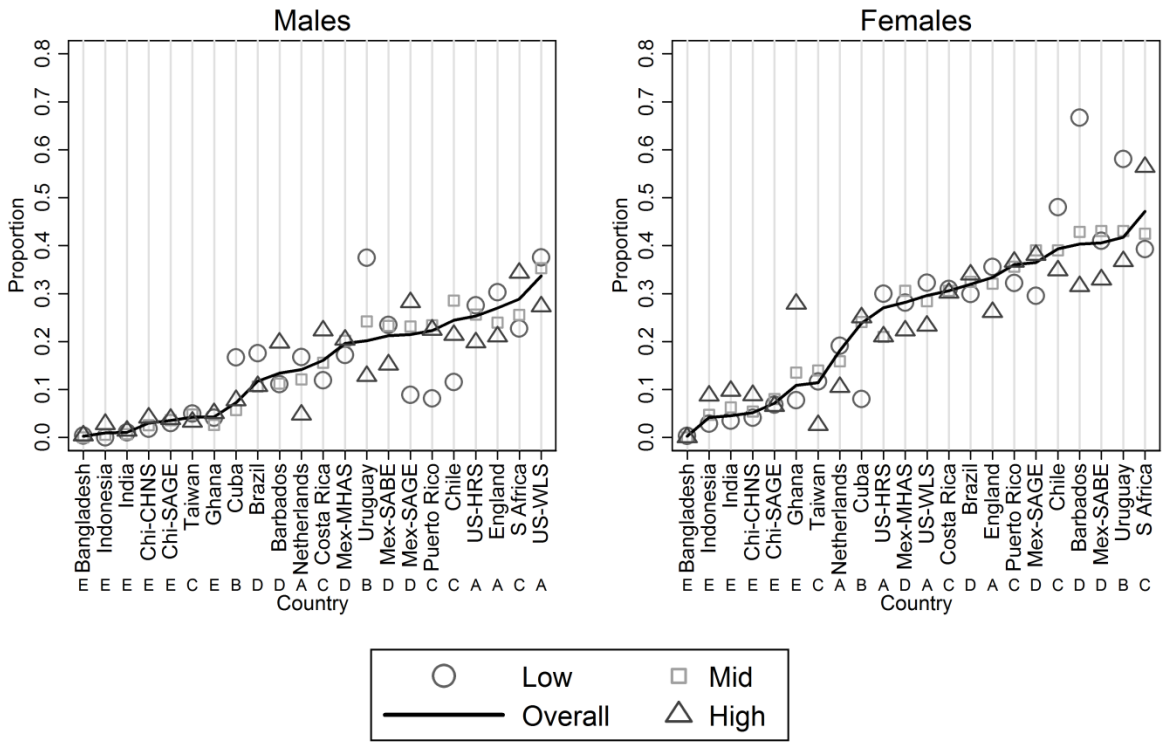

Figure 5: Prevalence of obesity by level of education

Source: RELATE data (2013).

Notes:

For developing countries, low = no school, mid = primary school, and high = secondary school or more; for developed countries, low = 0-12 years of education, mid = 13-15 years of education and high = 16 or more years of education.

Mortality regimes and corresponding countries:

A. Very early: England, Netherlands, US-HRS, US-WLS
B. Early: Argentina, Cuba, Uruguay
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E. Very Late: China-CHNS, China-CLHLS, China-SAGE, India, Indonesia, Ghana

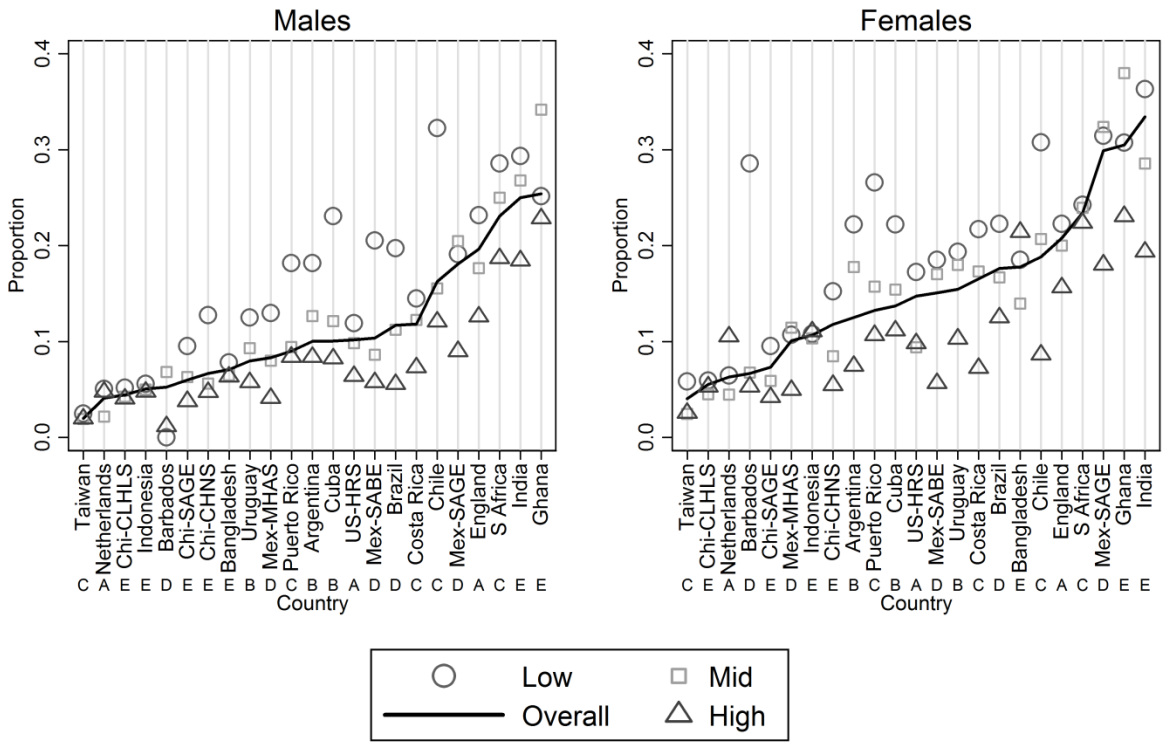

Figure 6: Proportion reporting at least one difficulty with functionality by level of education

Source: RELATE data (2013).

Notes:

For developing countries, low = no school, mid = primary school, and high = secondary school or more; for developed countries, low = 0-12 years of education, mid = 13-15 years of education and high = 16 or more years of education.

Mortality regimes and corresponding countries:

A. Very early: England, Netherlands, US-HRS, US-WLS
B. Early: Argentina, Cuba, Uruguay
C. Mid: Chile, Costa Rica, Puerto Rico, Taiwan, South Africa
D. Late: Barbados, Brazil, Mexico-MHAS, Mexico-SABE.
E. Very Late: China-CHNS, China-CLHLS, China-SAGE, India, Indonesia, Ghana

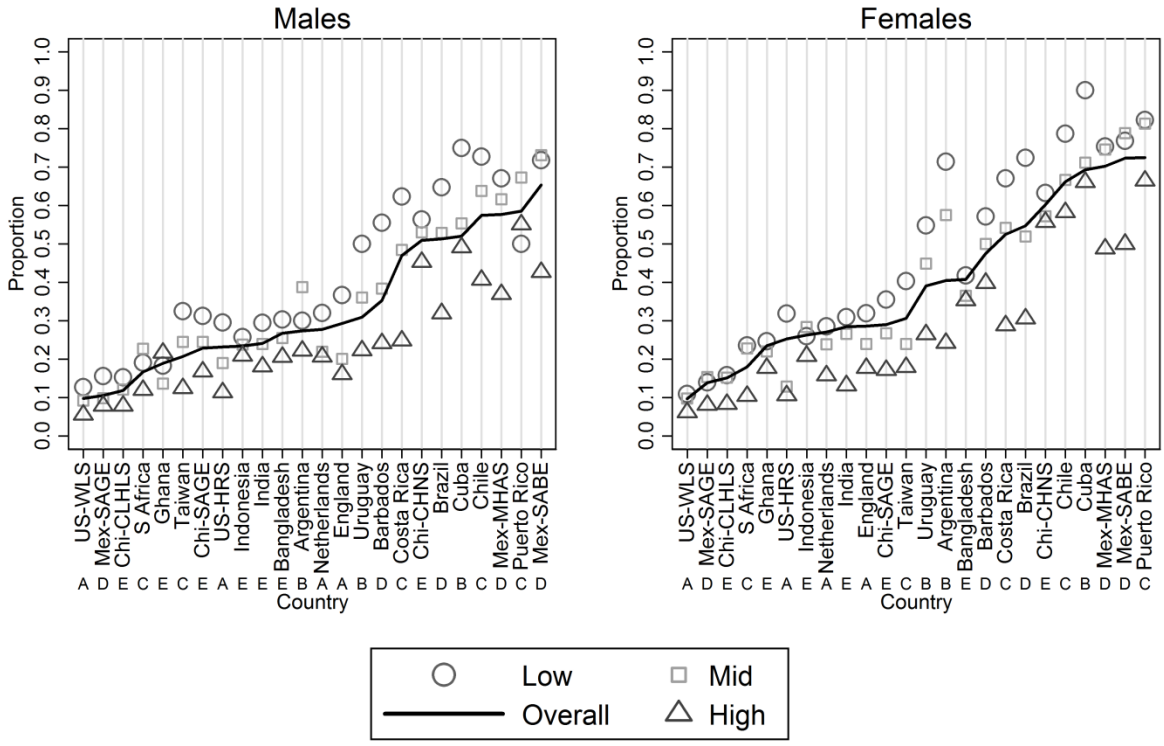

Figure 7: Proportion reporting poor self-reported health by level of education

Source: RELATE data (2013).

For developing countries, low = no school, mid = primary school, and high = secondary school or more; for developed countries, low = 0-12 years of education, mid = 13-15 years of education and high = 16 or more years of education.

Mortality regimes and corresponding countries:

A. Very early: England, Netherlands, US-HRS, US-WLS
B. Early: Argentina, Cuba, Uruguay
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D. Late: Barbados, Brazil, Mexico-MHAS, Mexico-SABE.
E. Very Late: China-CHNS, China-CLHLS, China-SAGE, India, Indonesia, Ghana

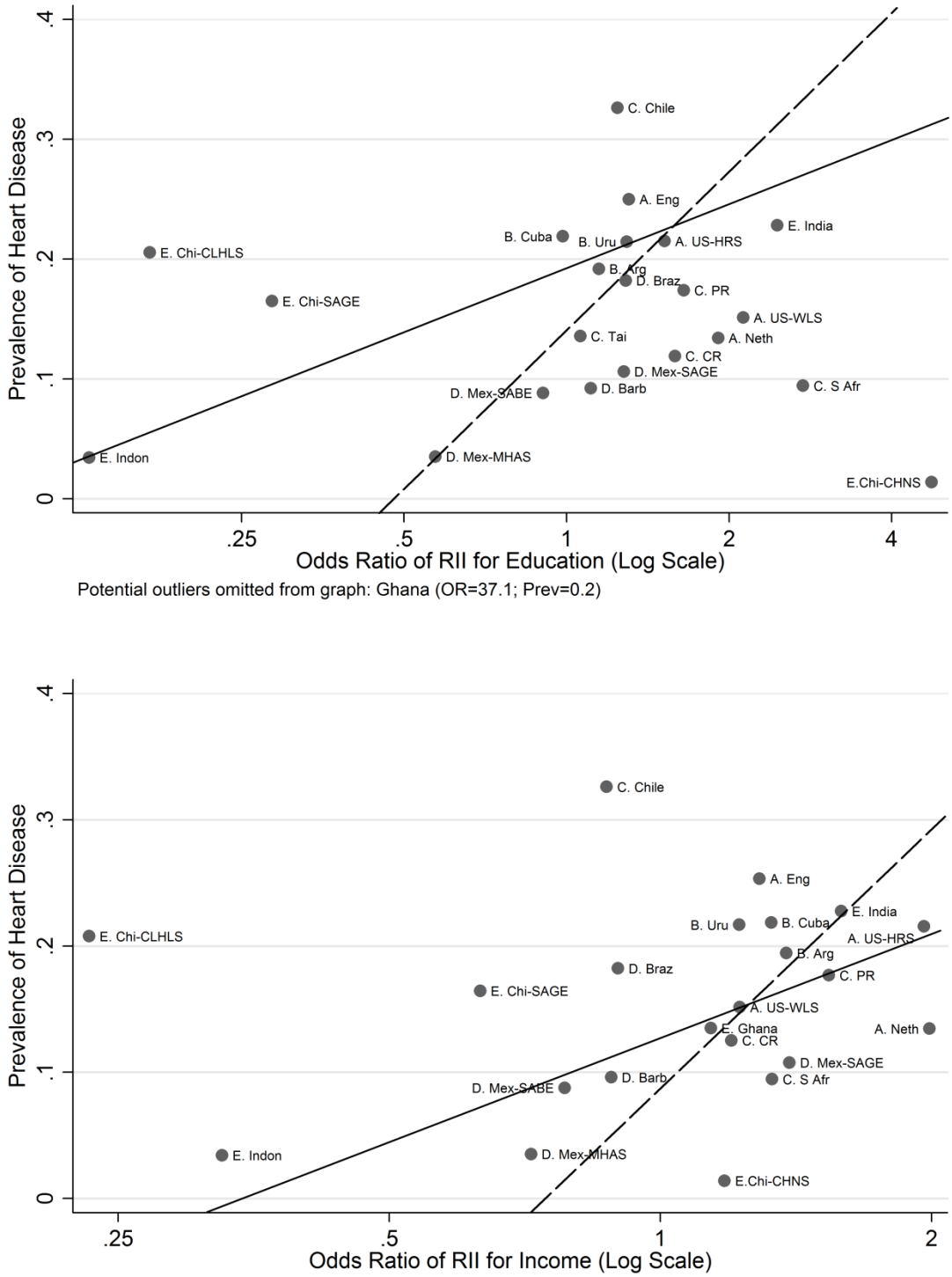

Figure 8: Association between the relative index of inequality and the prevalence of adult heart disease

Source: RELATE data (2013). Mortality regimes along with countries are depicted in the graph as: A. Very early; B. Early; C. Mid; D; Late; and E. Very late.

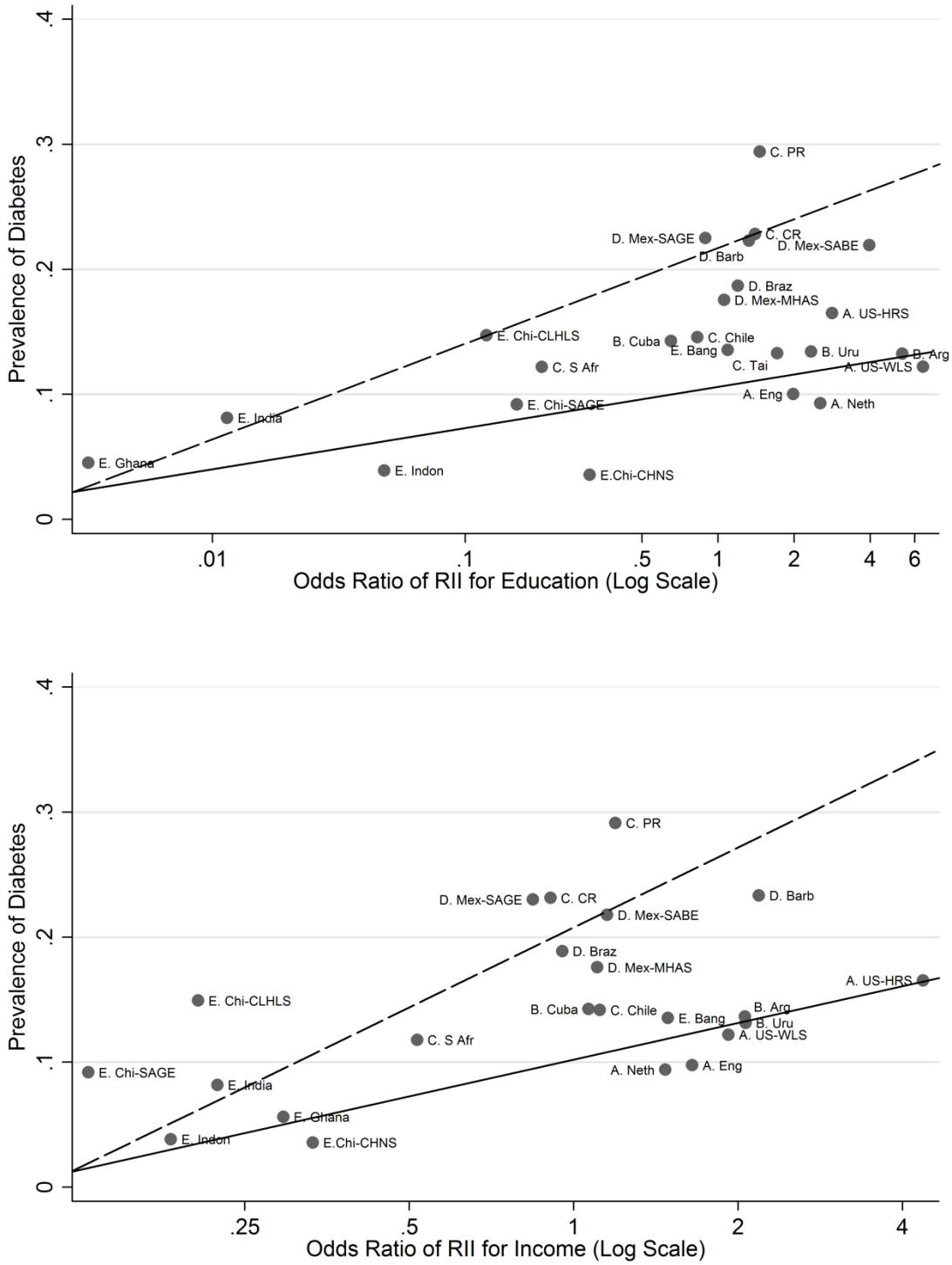

Figure 9: Association between the relative index of inequality and the prevalence of adult diabetes

Source: RELATE data (2013). Mortality regimes along with countries are depicted in the graph as: A. Very early; B. Early; C. Mid; D; Late; and E. Very late.

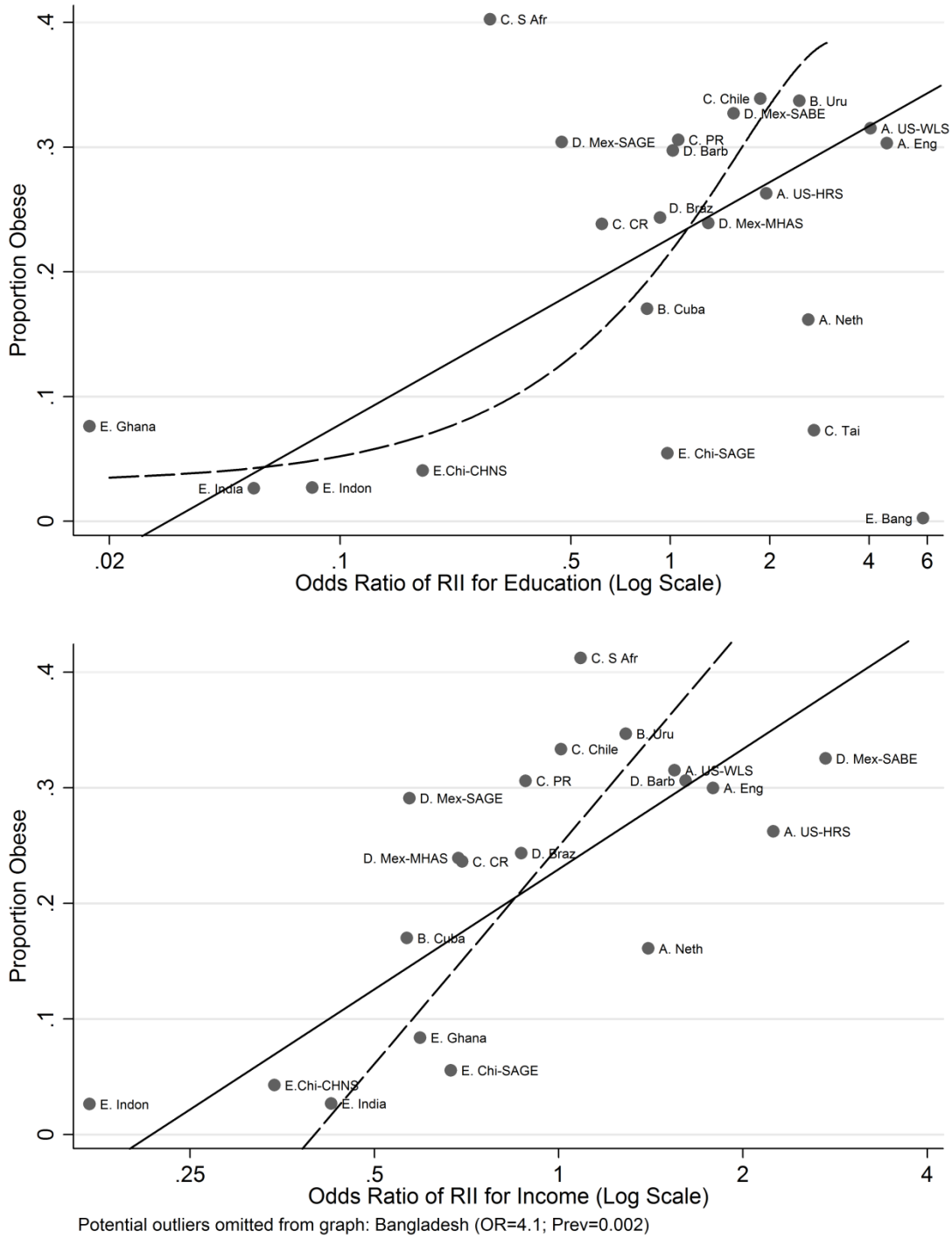

Figure 10: Association between the relative index of inequality and the prevalence of obesity

Source: RELATE data (2013). Mortality regimes along with countries are depicted in the graph as: A. Very early; B. Early; C. Mid; D; Late; and E. Very late.

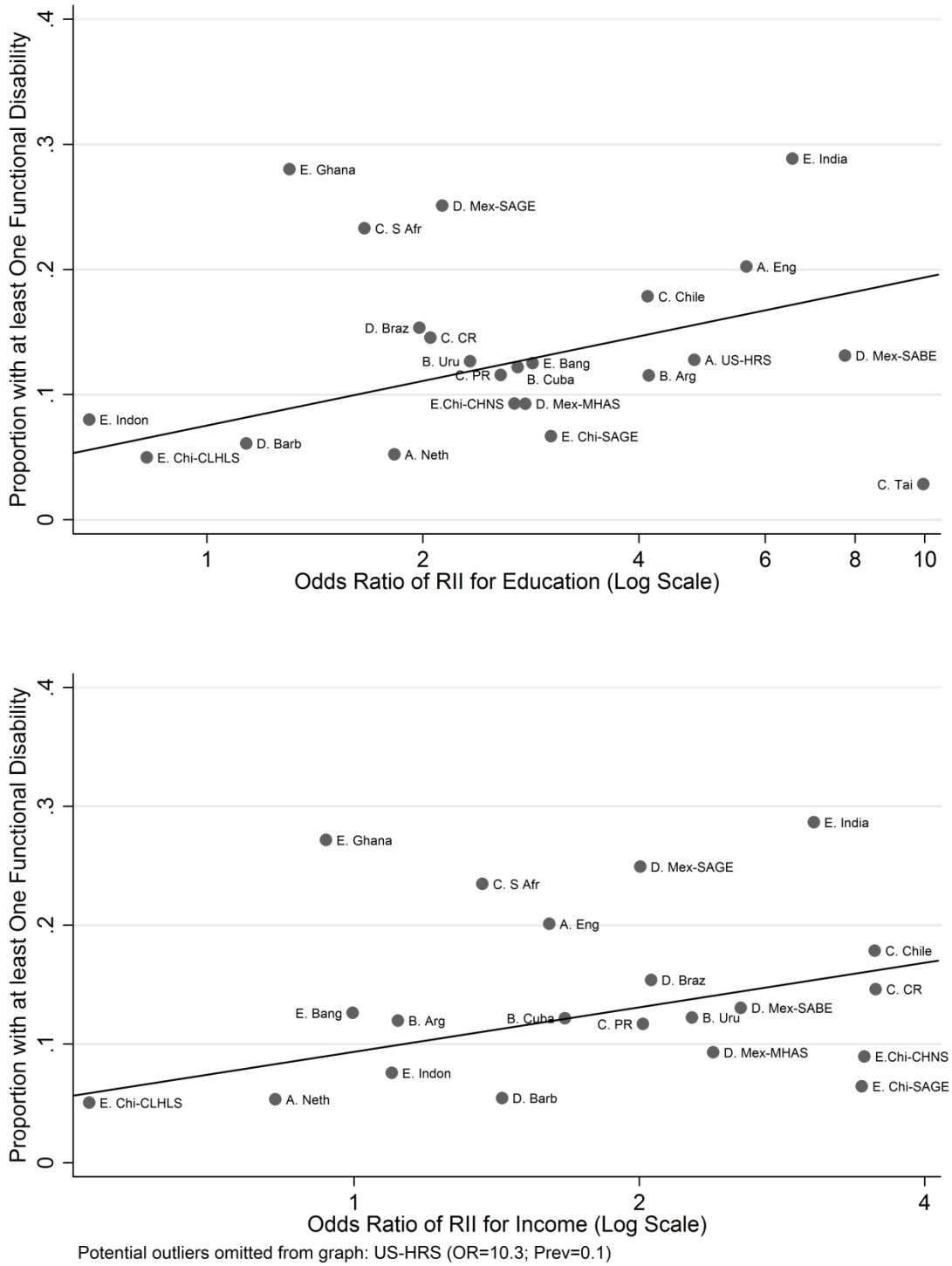

Figure 11: Association between the relative index of inequality and the proportion reporting at least one difficulty with functionality

Source: RELATE data (2013). Mortality regimes along with countries are depicted in the graph as: A. Very early; B. Early; C. Mid; D; Late; and E. Very late.

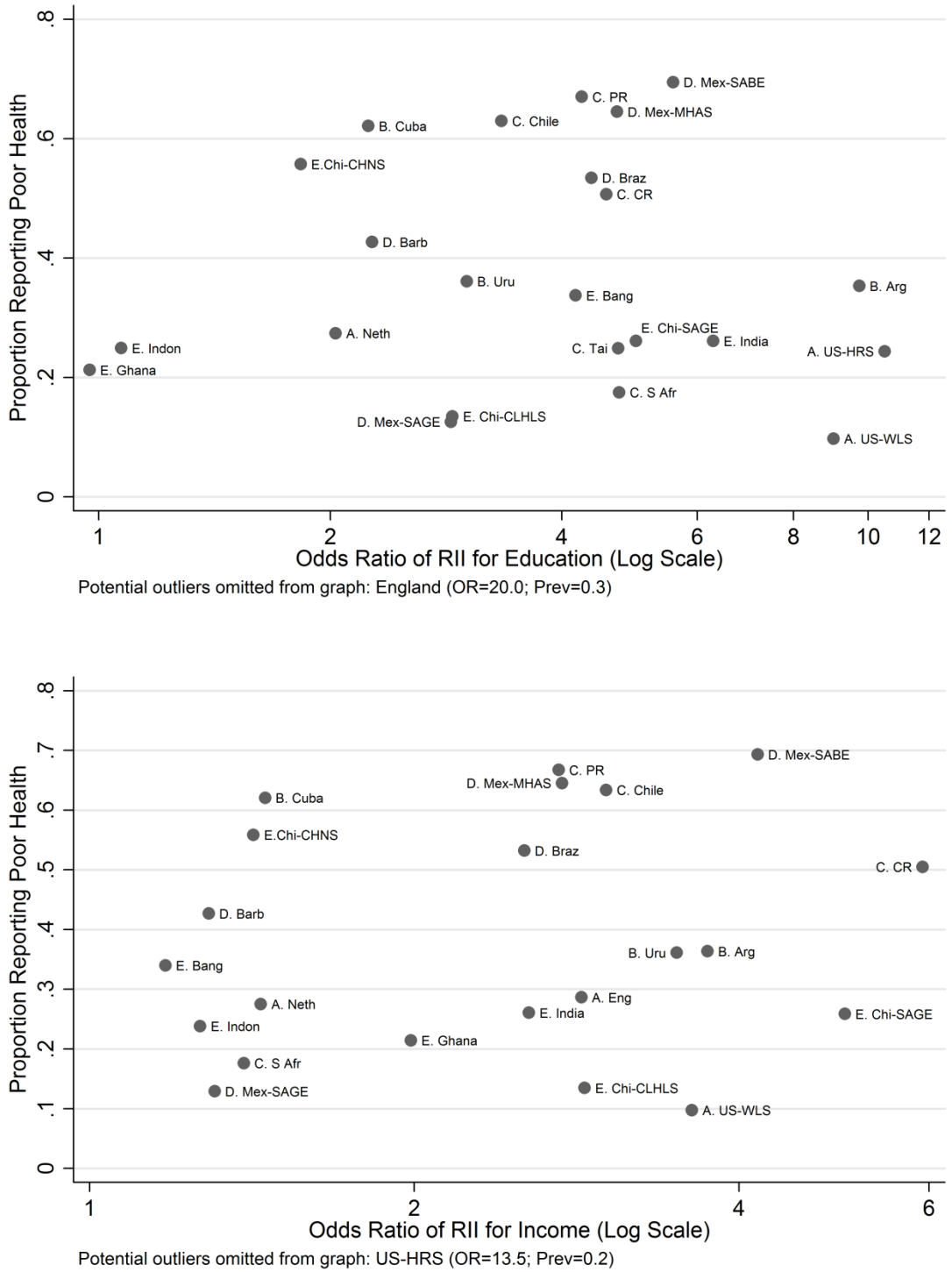

Figure 12: Association between the relative index of inequality and reporting poor health

Source: RELATE data (2013). Mortality regimes along with countries are depicted in the graph as: A. Very early; B. Early; C. Mid; D; Late; and E. Very late.