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Early life conditions and health disparities among aging populations in Latin America, the Caribbean and Asia

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CDE Working Paper No. 2010-01

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September 2009

This research was supported by a National Institute on Aging grant [K25 AG027239]. Research work for University of Wisconsin—Madison researchers is supported by core grants to the Center for Demography and Ecology, University of Wisconsin [R24 HD47873] and to the Center for Demography of Health and Aging, University of Wisconsin [P30 AG017266]. I also wish to acknowledge the rich intellectual stimulation from Alberto Palloni and am grateful to other individuals who in one way or the other have supported my research. These include: Dr. Nurul Alam, Paul Kowall, John Carlson, Janet Clear, and Sarah Moen.

Abstract

The dramatic mortality decline of the 1930s-1960s in developing countries may have created a larger pool of adult survivors of poor childhood conditions. If hypotheses regarding the importance of early life exposures on adult health have merit, we would expect to observe that the health of older adults from these cohorts would be unduly influenced by these exposures. We examined this conjecture by selecting a cross-national sample of adults 60 years and older that were born during different stages (regimes) of mortality decline using data from major studies on aging in Latin America (Costa Rica, Mexico, major cities), the Caribbean (Puerto Rico, Cuba, Barbados), Asia (China, India, Indonesia, Bangladesh, Taiwan), the US, the UK and the Netherlands. We estimated the effects of education and household per capita income on heart disease, diabetes, obesity and poor self-reported health. We also used Waaler-type mortality surfaces to estimate expected relative risk of mortality and compared expected mortality risk by education and income level. Findings: (1) we found a very mixed pattern of steeper health disparities for heart disease, diabetes and obesity which did not always correspond with our expectation regarding older adults in countries most at risk of having suffered adverse childhood conditions; (2) a very clear pattern of disparities in expected relative risk of mortality based on height using Waaler-type surfaces. Implications: there is very weak evidence to suggest that countries which most probably produced a larger number of survivors of poor early childhood conditions as a result of public health interventions and medical technology largely in the absence of improvements in standard of living are also countries with steeper and stronger socioeconomic (SES) disparities among older adults.

Introduction

The aim of this paper is to examine the degree to which there is evidence to support the conjecture that differences in the evolution of mortality in the developing world during the 20th century have important implications for health among elderly adults. Because the relatively compressed schedule of aging in countries (for example, in the Latin American and Caribbean region) can in part be traced to the medical and public health revolution that triggered the mortality decline over half a century ago (Preston, 1976; Palloni et al., 2007), it may be possible to observe differences in elderly health patterns according to the nature of (timing and speed) and reasons for mortality decline. These particular characteristics of mortality decline may have created cohorts with differential health experiences leading to different health patterns later in the life course.

Mortality began to decline in the early 20th century in some countries of the developing world and by the 1930s-1960s many countries experienced rapid mortality decline. The primary reasons for mortality decline in the early 20th century was a mixture of improvements in standards of living, public health interventions and medical technology (Preston, 1976) and countries differed according to the timing and pace of their health transition. Thus, different patterns of mortality decline emerged. Countries in the Latin American and Caribbean region such as Argentina and Uruguay which already had a relatively high standard of living in the early 20th century experienced a more graded mortality decline during the first part of the century. Other countries such as Chile, Costa Rica, Puerto Rico, South Africa and Taiwan could be considered more mid-paced regimes. For the most part they experienced an early but less graded mortality decline over the course of the first part of the 20th century. Consistent mortality decline began in the 1920s and was due more to preventive public health interventions than to improvements in standard of living. Larger countries such as Brazil and Mexico experienced earlier mortality decline but the dramatic declines in mortality occurred after 1940. Very small countries such as Barbados also experienced late and rapid mortality decline after 1940 and other countries such as Indonesia, Bangladesh, India, China and Ghana experienced significant mortality decline during the 1950s.

The mortality decline during the 1930s-1960s was primarily due to public health interventions and improved medical technology (Preston, 1976), the gains of which were concentrated early in the life of individuals, between birth and age 5 or 10. However, while most countries experienced improvements in life expectancy during this period, the magnitude of the mortality decline at younger ages differed across countries according to the nature of (timing and pace) and reason for the mortality decline that had occurred--for the most part earlier regimes experienced less dramatic improvements and gains in infant and child mortality than did the mid-to-later regimes.

The relevance of the different mortality patterns experienced during the early 20th century to the health of today's aging population in the developing world is due to the increasing evidence of the importance of early childhood conditions on adult health. Exposure to poor nutrition during pregnancy can lead to adult chronic conditions such as diabetes and heart disease (Barker, 1998; Eriksson et al., 2001). Both poor childhood socioeconomic conditions (SES) and childhood health can also have substantial impacts on adult health and chronic conditions (Lundberg, 1991; Hertzman, 1994; Wadsworth et al., 2002; Wadsworth & Kuh, 1997; Davey Smith & Lynch, 2004; Elo & Preston, 1992). Chronic conditions such as heart disease and diabetes are projected to dramatically increase in the developing world (Murray & Lopez, 1996). There are important public health ramifications regarding services for older adults and programs for mothers and children if poor early life exposures are important determinants of heart disease or diabetes.

The mid-paced (Costa Rica, Chile, Puerto Rico, Taiwan, South Africa) to late (Mexico, Brazil, Barbados) and very late, rapid (China, Bangladesh, India) mortality decline experienced by some cohorts born during the 1930s-1960s is of particular interest because it produced a larger cohort of individuals who survived poor early childhood conditions, many of whom may also have reached older adult ages. These cohorts are more at risk of having been affected by harsh early childhood experiences while at the same time had larger probabilities of surviving. Prior to the mid 1940s, the mid-paced regimes experienced important increases in infant and child survival whereas it was only after the 1940s that the later regimes experienced major improvements. Thus, older adults born in mid-paced cohorts prior to the mid 1940s may be able to provide some insights into whether early childhood experiences are indeed important in later life because they were less affected by mortality-driven selection than the group of cohorts who preceded them (those aged 75 and older) but were also less affected than the group of cohorts who were born in very late regimes during the same period.

If the Barker hypothesis (or any other hypothesis regarding the importance of childhood conditions) has merit, we would expect to observe that the adult health of these cohorts (and in particular the mid-paced regimes prior to the mid 1940s) has been unduly influenced by poor early childhood conditions. For the most part those that were exposed to poor early life conditions (e.g. poor nutrition, harsh living environments) and then survived those conditions due to public health interventions or medical technology were poor, especially in the age prior to antibiotics. Higher survivorship of the poor did not necessarily translate into improved standard of living during childhood or throughout the life course. Thus, if the conjecture has merit and if early life conditions are indeed important to older adult health then a comparison of health status by educational or income level should show increasingly stronger health disparities as we move from the very early regimes to the very late regimes, controlling for confounding factors.

However, international comparisons of health disparities are difficult because of the complexities that are behind the contrasts: (1) other mechanisms such as improved health care systems or changes in health behavior may also affect health. Such might be the case of Costa Rica which has an exemplary primary health care system. (2) 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 of 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. (3) 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 et al. 2004). It may also be that this phenomenon blurs the difference between SES levels within countries which show an uneven progress in the health transition. (4) More unequal societies may naturally have more negative impact on health (Banks et al., 2006) and thus distinguishing the effects of poor early life conditions may be challenging at best. (5) Measurement of income is not standardized across many countries, thus making legitimate comparisons more difficult. Even with the measure of years of education, it may be that countries have different thresholds which distinguish those with more or less socioeconomic standing. Furthermore, comparison by education between high income countries and low to middle income countries is difficult because of the large differences in the distribution of years of education. (6) There is unknown measurement error of health outcomes across countries even when survey questions are identical.

A comparison of health status by educational and income level is thus not only a very indirect test of the conjecture but one that is fraught with the difficulty of controlling for confounding factors. A more direct way of testing the conjecture is to examine differences in expected relative risk of mortality according to adult height and weight. Height is a well known marker of early nutrition and for the most part taller height is associated with better health (Waaler, 1984; Fogel, 2004). Using height and weight to estimate expected relative risk of mortality through Waaler surfaces is one way to link early life conditions to adult health and to illustrate differences in mortality outcomes (Fogel, 2004; Palloni et al., 2007). This type of approach may also help illuminate the conjecture tested in this paper.

In this paper, we examine the health of older adults born during the late 1920s and early 1940s[1] to test the conjecture that countries which most probably produced a larger number of survivors of poor early childhood conditions as a result of public health interventions and medical technology largely in the absence of improvements in standard of living are also countries with steeper and stronger SES disparities among older adults.[2] We expect to observe the following regularities in a comparison across all types of regimes: (1) a general pattern of steeper health disparities in the mid-paced to late regimes across all health outcomes; and (2) a reversal of the health gradient in the very late regimes. When we compare within regimes, we expect to observe the following: (1) steeper health disparities in early regimes such as Argentina and Uruguay as compared with Cuba which experienced a very different approach to health care; (2) steeper health disparities within mid-paced regimes such as Puerto Rico or Chile as compared

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[1] Data on 60-year old adults are, of course, not yet available for those born in the 1950s and for the most part we have data on adults born prior to 1945.

[2] These are countries in the mid-paced to very late demographic regimes as described previously.

with other mid-paced regimes which either have quality primary health care systems (Costa Rica) or which experienced large economic improvements in the 20th century (Taiwan); or (3) 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. Finally, we expect that our calculations using expected relative risk of mortality using height and weight via Waaler-type surfaces will provide better direct insight into the testing of the conjecture than the indirect approach of merely contrasting SES gradients across different adult health outcomes.

Method

Data

The data used to test the conjecture come from comprehensive national representative surveys of older adults or household surveys. From Latin America there are the Mexican Health and Aging Study (**MHAS**, first wave, n=7171), Puerto Rican Elderly: Health Conditions (**PREHCO**, first wave, n=4291), Survey on Health, Well-Being, and Aging in Latin America and the Caribbean (**SABE**, n=10,597), and Costa Rican Study of Longevity and Healthy Aging (**CRELES**, first wave, n=2827). From Asia there are the China Health and Nutrition Study (**CHNS**, n=5772), Indonesia Family Life Survey (**IFLS**, wave 2000, n=3998), the Bangladesh Matlab Health and Socio-Economic Survey (**MHSS**, n= 3721), WHO Study on Global Ageing and Adult Health Study in India (**WHO-SAGE**, first wave, n=6559) and Social Environment and Biomarkers of Aging Study (**SEBAS**, n=1023). From the developed world there are the Health and Retirement Study (**HRS**, wave 2000, n=12,527), Wisconsin Longitudinal Study (**WLS**, wave 2004, n=7265), English Longitudinal Study of Ageing (**ELSA**, second wave, n=8780), and

Survey of Health, Ageing and Retirement-Netherlands (**SHARE-Netherlands**, first wave, n= 2979).

Measures

Demographic regimes.—Countries were classified into different demographic regimes using historical data on life expectancy, infant mortality rates, GDP per capita and literacy rates according to the following characteristics of mortality decline during the health transition: 1) speed of mortality decline; 2) timing of the onset of mortality decline; 3) the degree to which mortality decline was due to exposure to public health interventions and medical technology; and 4) the degree to which mortality decline was due to improvements in standard of living (McEniry, 2009a). The regimes are: (A) very early, graded mortality decline (Netherlands, UK, US); (B) early, graded mortality decline (Argentina, Uruguay, Cuba); (C) mid, less graded mortality decline (Chile, Costa Rica, Puerto Rico, Taiwan); (D) late, rapid mortality decline (Mexico, Brazil, Barbados); and (E) little or no mortality decline prior to 1950 but rapid during the 1950s (India, Bangladesh, China, Indonesia).

Childhood conditions.—Early life conditions included lowest quartile of height, an indicator of nutrition during early childhood and possibly earlier. A retrospective question asked respondents about socioeconomic conditions during childhood, mother's and father's educational level. In most surveys it was possible to ascertain if the respondent had been born and raised in rural areas during childhood.

Adult SES.— Levels of education were defined according to the number of years of education and using UN 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 were defined because, for the most part, many countries had a very small number of respondents with greater than 12 years of education. Dummy variables for education were created to reflect no schooling, primary school and secondary school and above. In the case of the US, UK and Netherlands, we also used three levels according to what has been suggested by others (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. Tercile of income was then computed for all respondents in the survey (aged 50+). Dummy variables for the level of income were constructed and used for model estimation.

Adult Health.— Older adult health was defined by dichotomous variables using self-reported heart disease and self-reported diabetes. These variables ask the respondent if a doctor has ever diagnosed them with heart disease or diabetes. We defined a dummy variable to reflect different categories of Body Mass Index (BMI): underweight (<=18.5 BMI), normal (18.5>BMI<25), overweight (25>=BMI<30), obese (>=30 BMI). In most cases height and weight were measured by interviewers and in some cases it was self-reported (WLS) or a combination of the two (MHAS). Poor self-reported health was defined according to either bad or poor health and a dichotomous variable created to reflect it. Mortality was defined as a dichotomous variable (0/1) for those countries which had available mortality data. We also estimated the expected relative risk of mortality using Waaler-modified surfaces (see below).

Data preparation

We used multiple imputation procedures using ICE (Royston, 2004) in Stata to ensure that all cases were included. The number of missing values varied between countries in some cases because of the sampling frame used. In general, imputed results gave more conservative results and thus we present imputed results in the paper.

Analysis

There were two main parts to the analysis. In the first part, we estimated a series of graphs using imputed data showing overall health disparities across countries by educational and per capita household income level and then also by gender by educational level. There may very well be important gender differences in health disparities (Banks et al., 2006). We then estimated individual multivariate models using imputed data to estimate the effects of education and income on heart disease, diabetes, obesity and poor self-reported health. We then pooled the data and estimated several models, testing for both constrained and non-constrained models[3] and the differences between countries. In the second part of the analysis, we estimated several modified Waaler-type surfaces in order to obtain **expected relative mortality risk.** These surfaces, shown to be useful in depicting mortality risk (Waaler, 1984; Fogel, 2004; Palloni et al., 2007), are especially helpful in cases where no mortality data yet exists on individuals. Several surfaces were constructed using as standards or benchmarks (1) Waaler data (1984) and (2) mortality data from individuals in countries where panel data were available (Mexico, Puerto Rico, Costa Rica, China, Indonesia, Bangladesh, US).[4] Expected mortality risk for a particular gender, age group and height-pair was defined in relation to the group's overall expected mortality risk by gender and age group. We first estimated mortality risk by gender for the 60-74-year olds and then by height-weight category. By gender, we then calculated expected relative risk as the ratio between expected mortality risk for a particular height-weight category and expected mortality risk. We then estimated a quadratic regression model to model the function:

[3] Constrained models assumed that country effects were all equal; unconstrained models assumed that there were differences among countries.
[4] No mortality data yet available for ELSA and waiting for respondent mortality data for Netherlands, wave 2.

Ln(relative risk of mortality)=f(height, weight)

We selected the surface using Waaler data (1984) for presentation in this paper. The Waaler data has been used in other instances to create surfaces (Fogel, 2004; Palloni et al., 2007). The surfaces are based on the following models:[5]

***Waaler 1984 mortality surface (males)**:*

ln(RR)=6.30+(.020*W)+(-.065*H)+(.0005*(W^2))+(.0003*(H^2))+(-.0006*H*W)

***Waaler 1984 mortality surface (females)**:*

ln(RR)=24.39+(-.017*W)+(-.275*H)+(.0005*(W^2))+(.0009*(H^2))+(-.0004*H*W)

We used data on average height and weight to compute overall expected relative risk of mortality and then similarly by either educational level (no schooling, primary, secondary and above) or by tercile of per capita household income.

Results

Sample characteristics

Sample characteristics of countries using imputed data showed no major anomalies (Table 1). Female respondents were predominant with the exception of Bangladesh and as one moves from the very early regimes to later regimes there is an increase in the percentage of respondents with lower educational and per capita household income levels. Overall prevalence and prevalence by educational level and per capita household income for adult heart disease, diabetes and obesity for the cohort born in the late 1920s and early 1940s, sorting countries in order from lowest prevalence to highest prevalence, are shown in a series of graphs (Figures 1-5). Not surprisingly

[5] Coefficients have been rounded and so may not produce the exact graph as presented in this paper.

(with the exception of Chile), older adults born in earlier regimes (i.e. HRS, UK, Uruguay, Cuba and Argentina) showed a higher prevalence of heart disease than those born in later regimes (Figure 1). Mexico (surprisingly) has a much lower prevalence of heart disease than do other late regimes (Figure 1). For the most part, there are larger disparities in heart disease by education for females and there appears to be a reversal of the gradient in countries such as Mexico, Barbados, Brazil, and the US for males and India, Brazil and Chile for females.

[Insert Table 1, Figure 1 about here]

In the case of diabetes we observe that the mid-to-late regimes have a higher prevalence of diabetes (Figure 2) and that there is more disparity within countries both for males and females. For the most part, the gradient is 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 China, India and Bangladesh where, as we expected (Monteiro et al. 2004), we observe a clear reversal of the gradient—higher prevalence of diabetes at higher educational levels. For males, the reversal is also noted for Cuba, Chile, and Brazil. Overall, larger educational disparities appear in Barbados and Mexico for males and Argentina, Uruguay, Taiwan and Barbados and Mexico for females.

[Insert Figure 2 about here]

With obesity (Figure 3), we observe that the very early regimes for the most part have a higher prevalence of obesity for males but in the case of females there is also higher prevalence of obesity in Chile, Mexico and Barbados. Not surprisingly, Bangladesh, India and China are at the lower end of prevalence of obesity. There is some reversal of the expected pattern of the gradient such as in Barbados and Costa Rica for males. The largest educational differences appear in Barbados for females and Uruguay for males.

[Insert Figure 3 about here]

In comparison with all other health outcomes, poor self-reported health shows a clearer pattern of differences within and across countries, although for the most part the gradient is clearly a higher proportion of poor self-reported health at lower educational and income levels (Figure 4). Large disparities appear in Costa Rica, Brazil and Mexico. For countries having mortality data, we observe that the highest proportion of deaths occurs in Bangladesh and Indonesia and that these countries also show the largest disparities between lower and higher educational levels (Figure 5). Indonesia shows a puzzling reversed pattern for both males and females.

[Insert Figures 4 and 5 about here]

Multivariate Models

Country-specific models estimating the effects of education on adult health showed stronger effects in the very early regimes (UK and the US) than they did in other countries (Table 2). In spite of potential differences in threshold levels across countries in reporting poor health, stronger effects appeared in poor self-reported health than in other health outcomes. There was a clear pattern—the odds of reporting poor health were higher at lower educational levels across countries. In other health outcomes, the odds of heart disease were smaller at higher educational levels except in Brazil and India and the odds of diabetes were smaller at higher educational levels except for India, the odds of death were also smaller at higher educational levels except for Indonesia. Repeating the analysis for tercile of per capita household income produced similar results (Table 3). There were more notable significant findings in the very early regime countries (UK, US and Netherlands) as there were in poor self-reported health.

[Insert Tables 2 & 3 about here.]

Pooled models using constrained and unconstrained models for all countries showed similar effects of education on health in the early-to-mid regimes—lower odds of reporting heart disease, diabetes, poor self-reported health or being obese at higher educational levels (Table 4). However, this pattern was reversed in the late regimes of Brazil, Mexico and Barbados and the very late regimes of Bangladesh, China, Indonesia and India. Pooled models using tercile of per capita household income produced similar results (Table 5).

[Insert Table 4 & 5 about here.]

Expected Relative Risk of Mortality using Waaler-Type Surfaces

A graph based on the results of estimating expected relative risk of mortality using modified Waaler-type surface for adult males and females by educational level and income based on Waaler mortality data (1984) is shown in Figure 6. A comparison of males and females given their average height and weight by educational level, made under the assumption that **Waaler 1984 Norwegian relative risk can be applied to other countries**, shows a clear pattern of higher expected relative risk for lower educated individuals than for more educated individuals. In most countries, individuals with lower educational levels have higher expected relative mortality risk than individuals with higher educational levels. As expected, almost no differences appear in the very early regimes of UK, US and the Netherlands whereas larger differences appear in women in Mexico, China, India, Indonesia and Bangladesh. Using income produces similar results.

[Insert Figure 6 about here.]

Discussion

This paper examined in a very preliminary manner data to test a conjecture based on the nature of mortality decline during the 1930s-1960s in developing countries which created a large pool of survivors of poor early life conditions largely as a result of public health interventions and medical technology but in the absence of significant improvements in standard of living. When we compared across countries and regimes by gender (1) we found a very mixed pattern of steeper health disparities which did not always correspond with our expectation regarding mid-paced to late regimes; however, (2) we did find an expected reversal of the health gradient in some of the late regime countries and in some of the mid-paced to late regime countries. When we compared within regimes, we observed: (1) (as expected) steeper health disparities in Argentina and Uruguay for some health outcomes as compared with Cuba; (2) (not as expected) no consistent large differences in health disparities in Puerto Rico or Chile as compared with

Costa Rica or Taiwan; and (3) in some cases steeper health disparities within late to very late regimes such as Bangladesh, Indonesia and India in comparison with China. As expected, estimating expected relative risk of mortality via Waaler-type surfaces provided better direct insight into the testing of the conjecture as a very clear pattern emerged that the mid-paced to later regimes overall had a higher expected relative risk of mortality.

It is not surprising that we did not observe more significant differences using the indirect approach to testing the conjecture by comparing SES gradients across countries by health outcomes. As we have mentioned at the beginning of the paper there are important complexities that are masked behind any simple SES contrast by adult health outcome. One of the most important complexities in terms of education is the threshold level at which education makes a difference within a country. The rather simple categories of "no schooling, primary and secondary and above" in the low to middle income countries need refinement and alternative definitions of education levels may prove to be more insightful. In terms of income, we already recognize the challenges posed by different ways of measuring income across countries. A future improvement is to examine a component of income across countries or to be satisfied with comparing only those countries where the measurement of income is comparable. For the time being, we tend to believe more in the educational comparisons than the income comparisons because of this measurement issue. Another important complexity blurring the picture is the reversal pattern that we noted and reported by others (Monteiro et al., 2004). For adults born in the late 1920s and early 1940s in countries such as China, Indonesia or India this reversal pattern is very clear. It may very well be that this is an important confounding factor in the mid-paced countries of Puerto Rico, Costa Rica and Chile which may have experienced within country a mixed pace of improvements, thus blurring the difference between SES levels within countries.

Another unresolved complexity is that education and income may have indirect effects on adult health--higher education and income affects behavior (smoking, exercise, diet) and it may be that the effects of education and income are mediated through adult behavior which then impacts adult health. Finally, the all-important differences in health care systems within regimes (Costa Rica in the mid-paced regimes; China in the very late regimes) causes us to pause and requires more examination.

We observed a very clear pattern of SES disparities when using Waaler-type surfaces. It is not surprising that height, as a marker of early nutrition, becomes more important by SES level as we move from mid-paced to very late regimes because nutrition has become less of an issue in higher than lower income countries. Yet, the picture remains incomplete. The Waaler surfaces based on Norwegian mortality data suggest similar expected relative risks for healthy older adults in mid-paced regimes but it is not clear the degree to which these potential mortality risks will translate into actual higher mortality rates at older ages. We thus need to further examine the smaller subset of countries where mortality data are available and compute the observed relative risk of mortality and compare it with the expected values obtained from the Waaler-type surfaces. When mortality data from other mid-paced regimes become available, it will be possible to further illuminate our results by examining differences in mortality within the mid-paced regimes which experienced dramatic economic growth (Taiwan) or have quality health care systems (Chile). However, the Waaler 1984 surface is descriptive of a relatively healthy population and a high income country in the 1980s and we make the important assumption that the expected relative risk of this population can be used to compare other populations. We are already examining other countries to construct Waaler-type surfaces which may be useful to the conjecture (McEniry, 2009b).

The challenge of finding evidence for the conjecture partially lies in being able to draw inferences from observing survivors but not complete cohorts of individuals. It also lies in the validity and reliability of health outcomes and childhood measures used in surveys, which, because of underestimation of chronic conditions, provides us with more conservative and lower bound estimates of the effects of early childhood conditions on adult health. The timing of surveys is also a potentially important limitation. All respondents are from cohorts born in the late 1920s and early 1940s but in some countries respondents were surveyed in 1996 (Bangladesh), 2000 (most countries), 2005 (UK, WLS) or later (India).

In spite of the study limitations, the ramifications of the research are important. The findings give one pause in terms of future public policy. Heart disease and diabetes are increasing in prevalence in the developing world (Murray & Lopez, 1996), and the cohorts born after 1945 (and before 1960) are approaching older adult ages. We do not know the degree to which the effects of adverse early conditions can be mediated through health care later in life nor do we have complete information on all mid-to-late regimes to estimate their increased predisposition to higher mortality risk from heart disease and diabetes due to early life conditions. We also do not know the degree to which later cohorts born after 1945 will also experience higher than average risk of heart disease and diabetes and mortality due to poor childhood conditions. Therefore, research efforts in this area continue to be important so that appropriate public policy decisions can be made if the conjecture has merit. This includes decisions regarding the types of interventions and programs that are needed not only for older adults to address the special health problems evident now and into the far future but also for mothers and children in the developing world to improve early life conditions and prevent heart disease and diabetes at older ages.

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Table 1: Basic characteristics for the 60-74 years old

			Educational Levels		
Pais/Regime	**Male (%)**	**Female (%)**	**Low (%)**	**Mid (%)**	**High (%)**
Very Early					
Netherlands	47	53	69	28	3
UK	47	53	68	11	22
US-HRS	43	57	61	19	20
US-WLS	46	54	57	16	27
Early					
Argentina	39	61	6	34	61
Cuba	44	56	4	45	51
Uruguay	37	63	4	64	32
Mid-paced					
Chile	42	58	13	52	35
Costa Rica	48	52	12	65	23
Puerto Rico	45	55	4	34	62
Taiwan	56	44	30	48	22
Late					
Barbados	41	59	2	73	25
Brazil	43	57	22	65	14
Mexico-MHAS	48	52	33	52	15
Mexico-SABE	46	54	23	53	23
Very Late					
Bangladesh	52	48	63	28	9
China	48	52	41	37	22
India	54	46	54	22	23
Indonesia	46	54	56	34	11

For the Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education.
All other countries: low (no schooling), mid (primary), high (secondary, plus).

Table 2: Effects of education on adult health

Regime/Country	Level	Heart Disease	Diabetes	Obesity	Poor Health	Dead
Very Early						
Netherlands	Low	1.00	1.36	1.31	1.47	
(n=1311)		(0.18)	(0.32)	(0.23)	(0.21)**	
	High	0.63	0.66	0.36	0.72	
		(0.35)	(0.51)	(0.27)	(0.32)	
UK (n=5383)	Low	0.98	1.32	1.31	1.78	
		(0.11)	(0.22)	(0.16)*	(0.34)**	
	High	0.89	1.02	0.86	0.62	
		(0.11)	(0.20)	(0.11)	(0.14)*	
US-HRS	Low	1.10	1.51	1.39	2.41	1.13
(n=8360)		(0.08)	(0.13)***	(0.10)***	(0.19)***	(0.10)
	High	0.82	0.91	0.87	0.68	0.73
		(0.07)*	(0.10)	(0.08)	(0.07)***	(0.09)**
US-WLS	Low	1.18	1.24	1.15	1.26	1.04
(n=7265)		(0.11)	(0.13)*	(0.09)	(0.14)*	(0,16)
	High	0.91	0.65	0.73	0.59	0.49
		(0.91)	(0.08)***	(0.06)***	(0.08)***	(0.10)***
Early						
Argentina	Low	1.56	1.94		1.63	
(n=745)		(0.56)	(0.73)		(0.54)	
	High	0.99	0.53		0.29	
		(0.20)	(0.13)**		(0.05)***	
Cuba (n=1234)	Low	1.04	0.74	0.52	2.27	
		(0.38)	(0.37)	(0.29)	(0.96)	
	High	0.90	1.15	0.97	0.79	
		(0.13)	(0.19)	(0.17)	(0.10)	
Uruguay	Low	1.73	1.59	2.00	1.58	
(n=1013)		(0.60)	(0.60)	(0.65)*	(0.51)	
	High	0.85	0.59	0.69	0.45	
		(0.15)	(0.13)*	(0.10)*	(0.07)***	
Mid-paced						
Chile (n=858)	Low	1.23	1.04	1.06	1.62	
		(0.26)	(0.30)	(0.26)	(0.38)*	
	High	0.98	0.90	0.80	0.57	
		(0.17)	(0.21)	(0.14)	(0.09)***	
Costa Rica	Low	1.03	1.28	1.04	1.90	1.48
(n=1317)		(0.25)	(0.22)	(0.20)	(0.30)***	(0.44)
	High	0.89	0.83	1.07	0.40	1.44
		(0.23)	(0.16)	(0.20)	(0.07)***	(0.44)
Puerto Rico	Low	1.10	1.36	0.82	1.22	1.34
(n=2693)		(0.27)	(0.28)	(0.21)	(0.33)	(0.37)
	High	0.73	0.88	0.96	0.52	0.67
			(0.08)	(0.09)	(0.05)***	(0.09)**

Regime/Country	Level	Heart Disease	Diabetes	Obesity	Poor Health	Dead
		(0.08)**				
Taiwan (n=546)	Low	1.01 (0.31)	1.74 (0.50)	0.85 (0.32)	1.78 (0.43)*	
	High	1.14 (0.34)	1.14 (0.38)	0.48 (0.25)	0.57 (0.16)	
Late						
Barbados (n=923)	Low	1.26 (0.97)	1.50 (0.82)	1.66 (0.94)	1.49 (0.74)	
	High	1.33 (0.35)	0.81 (0.16)	0.88 (0.16)	0.65 (0.11)**	
Brazil (n=1141)	Low	1.28 (0.24)	1.07 (0.20)	1.08 (0.21)	2.18 (0.35)***	
	High	1.67 (0.36)*	1.00 (0.24)	1.18 (0.29)	0.41 (0.08)***	
Mexico-MHAS (n=5440)	Low	0.89 (0.15)	0.93 (0.08)	0.92 (0.07)	1.19 (0.09)*	1.28 (0.19)
	High	1.10 (0.21)	0.91 (0.09)	0.89 (0.09)	0.38 (0.03)***	0.97 (0.20)
Mexico-SABE (n=923)	Low	0.98 (0.29)	1.28 (0.24)	1.05 (0.20)	0.92 (0.18)	
	High	1.28 (0.36)	0.43 (0.11)***	0.64 (0.14)*	0.27 (0.05)***	
Very Late						
Bangladesh (n=1879)	Low		0.96 (0.15)		1.28 (0.15)*	1.24 (0.15)
	High		0.89 (0.26)		0.74 (0.15)	0.85 (0.19)
China (n=1529)	Low	0.65 (0.32)	0.53 (0.21)	0.82 (0.22)	1.10 (0.20)	1.28 (0.26)
	High	0.60 (0.36)	2.12 (0.89)	1.25 (0.37)	0.73 (0.17)	0.99 (0.26)
India (n=2949)	Low	0.47 (0.09)***	0.44 (0.09)***	0.58 (0.18)	1.18 (0.13)	
	High	0.82 (0.17)	2.41 (0.44)***	1.51 (0.52)	0.57 (0.08)***	
Indonesia (n=3495)	Low				0.90 (0.09)	0.62 (0.07)***
	High				1.02 (0.14)	1.14 (0.27)

Note: Using imputed country-specific data for those born late 1920s-early 1940s. For the Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education. All other countries: low (no schooling), mid (primary), high (secondary, plus). Not all countries asked specific questions about heart disease and diabetes. This includes Indonesia and Bangladesh. All data are imputed using Stata ICE imputation software. Mortality data were available for only 8 countries: US-WLS, US-HRS, Costa Rica, Mexico, Puerto Rico, China, Bangladesh and Indonesia.

Table 3: Effects of per capita household income on adult health

Regime/ Country	Income Level	Heart Disease	Diabetes	Obesity	Poor Health	Dead
Very Early						
Netherlands	Lowest	1.50	1.12	0.85	1.37	
(n=1311)		(0.31)*	(0.27)	(0.16)	(0.21)*	
	Highest	1.41	1.19	0.85	1.16	
		(0.29)	(0.28)	(0.16)	(0.18)	
UK	Lowest	1.01	0.94	1.19	1.05	
(n=4525)		(0.08)	(0.11)	(0.10)*	(0.08)	
	Highest	0.85	0.77	0.81	0.52	
		(0.07)	(0.10)*	(0.07)*	(0.05)***	
US-HRS	Lowest	1.27	1.83	1.34	2.39	1.74
(n=5440)		(0.08)***	(0.13)***	(0.09)***	(0.16)***	(0.15)***
	Highest	0.83	0.72	0.79	0.51	0.29
		(0.06)**	(0.06)***	(0.05)***	(0.04)***	(0.07)***
US-WLS	Lowest	1.06	1.19	1.07	1.60	1.14
(n=7265)		(0.09)	(0.10)	(0.08)	(0.15)***	(0.16)
	Highest	0.89	0.67	0.81	0.62	0.77
		(0.07)	(0.07)***	(0.06)**	(0.07)***	(0.12)
Early						
Argentina	Lowest	1.09	1.44		1.50	
(n=745)		(0.26)	(0.43)		(0.31)*	
	Highest	0.79	0.92		0.53	
		(0.19)	(0.28)		(0.13)**	
Cuba	Lowest	1.06	0.83	1.05	1.03	
(n=1234)		(0.18)	(0.18)	(0.24)	(0.17)	
	Highest	0.82	0.94	1.58	0.79	
		(0.14)	(0.20)	(0.34)*	(0.12)	
Uruguay	Lowest	0.95	1.26	1.15	1.56	
(n=1013)		(0.18)	(0.35)	(0.23)	(0.27)*	
	Highest	0.82	0.81	0.94	0.63	
		(0.18)	(0.21)	(0.18)	(0.12)*	
Mid-paced						
Chile	Lowest	0.91	1.39	1.22	1.66	
(n=858)		(0.20)	(0.34)	(0.31)	(0.34)*	
	Highest	0.94	1.01	1.23	0.84	
		(0.20)	(0.28)	(0.29)	(0.15)	
Costa Rica	Lowest	1.04	1.14	0.90	1.52	1.29
(n=1317)		(0.25)	(0.20)	(0.20)	(0.24)**	(0.48)
	Highest	0.86	1.01	1.19	0.49	1.37
		(0.20)	(0.16)	(0.21)	(0.07)***	(0.44)
Puerto Rico	Lowest	1.22	1.12	1.08	1.08	1.55
(n=2693)		(0.16)	(0.12)	(0.12)	(0.12)	(0.26)**
	Highest	0.92	0.95	1.13	0.62	0.85
		(0.12)	(0.11)	(0.1a)	(0.07)***	(0.15)

Regime/ Country	Income Level	Heart Disease	Diabetes	Obesity	Poor Health	Dead
Late						
Barbados	Lowest	1.58	1.00	1.14	0.92	
(n=923)		(0.54)	(0.25)	(0.34)	(0.18)	
	Highest	1.53	0.71	0.94	0.66	
		(0.49)	(0.17)	(0.25)	(0.16)	
Brazil	Lowest	0.94	1.26	0.85	1.64	
(n=1141)		(0.21)	(0.25)	(0.17)	(0.27)**	
	Highest	0.93	1.01	1.12	0.59	
		(0.17)	(0.21)	(0.21)	(0.10)***	
Mexico-	Lowest	0.88	0.97	0.72	1.50	1.04
MHAS		(0.16)	(0.08)	(0.07)***	(0.12)***	(0.17)
(n=5440)	Highest	1.30	0.86	0.97	0.77	0.95
		(0.22)	(0.08)	(0.09)	(0.06)**	(0.17)
Mexico-	Lowest	1.16	1.09	1.21	1.10	
SABE		(0.38)	(0.22)	(0.26)	(0.24)	
(n=923)	Highest	0.89	0.73	0.85	0.42	
		(0.30)	(0.15)	(0.20)	(0.09)***	
Very Late						
Bangladesh	Lowest		1.75		1.09	1.38
(n=1879)			(0.30)***		(0.13)	(0.17)**
	Highest		1.22		0.87	1.12
			(0.22)		(0.11)	(0.14)
China	Lowest	0.40	0.62	0.43	1.24	1.17
(n=1529)		(0.25)	(0.30)	(0.15)	(0.27)	(0.29)
	Highest	1.03	1.47	1.41	0.97	0.70
		(0.58)	(1.04)	(0.37)	(0.26)	(0.19)
India	Lowest	1.32	0.70	1.05	1.12	
(n=2889)		(0.28)	(0.14)	(0.33)	(0.12)	
	Highest	1.21	2.01	1.86	0.59	
		(0.26)	(0.35)***	(0.56)*	(0.07)***	
Indonesia	Lowest				1.09	0.88
(n=3495)					(0.12)	(0.08)
	Highest				0.97	0.94
					(0.11)	(0.09)

Notes: Using imputed country-specific data for those born late 1920s-early 1940s. Shown for income is the lowest and highest tercile of income—reference group is the middle tercile. Taiwan does not appear in this table because there were no household income data available.

Table 3: Effects of education on adult health using pooled data

	Early Regimes	Mid-Paced Regimes	Late Regimes	Very Late Regimes
Heart Disease				
No Schooling	1.40 (0.28)	1.09 (0.13)	1.04 (0.12)	0.47 (0.09)***
Secondary+	0.89 (0.08)	0.84 (0.07)*	1.31 (0.15)*	0.78 (0.15)
Diabetes				
No Schooling	1.37 (0.31)	1.36 (0.15)**	0.99 (0.07)	0.71 (0.08)**
Secondary+	0.78 (0.09)*	0.89 (0.07)	0.83 (0.07)*	2.04 (0.26)***
Obesity				
No Schooling	1.30 (0.33)	0.93 (0.10)	0.96 (0.06)	0.58 (0.09)***
Secondary+	0.82 (0.09)***	0.93 (0.07)	0.88 (0.06)	1.22 (0.22)
Poor Self-Reported Health				
No Schooling	1.87 (0.37)***	1.69 (0.17)***	1.29 (0.08)***	1.09 (0.06)
Secondary+	0.51 (0.04)***	0.51 (0.04)***	0.40 (0.03)***	0.73 (0.06)***
N observations	2992	5414	8427	9773

Notes: All of the models are unconstrained (i.e. country effects are not assumed to be zero) except heart disease and diabetes in the early regimes. Countries within regimes are: Early (Argentina, Uruguay, Cuba); Mid-Paced (Chile, Costa Rica, Puerto Rico); Late (Barbados, Brazil, Mexico); Very Late (Bangladesh, China, India, Indonesia).

*p<0.05, **p<0.01, ***p<0.001. Using imputed country-specific data for those born late 1920s-early 1940s. All models also controlled for gender and age. In the case of unconstrained models, country dummies were also included in models. The number of observations may vary within regimes because in some cases there were no data on obesity (Argentina, Bangladesh), heart disease (Indonesia, Bangladesh) or diabetes (Indonesia).

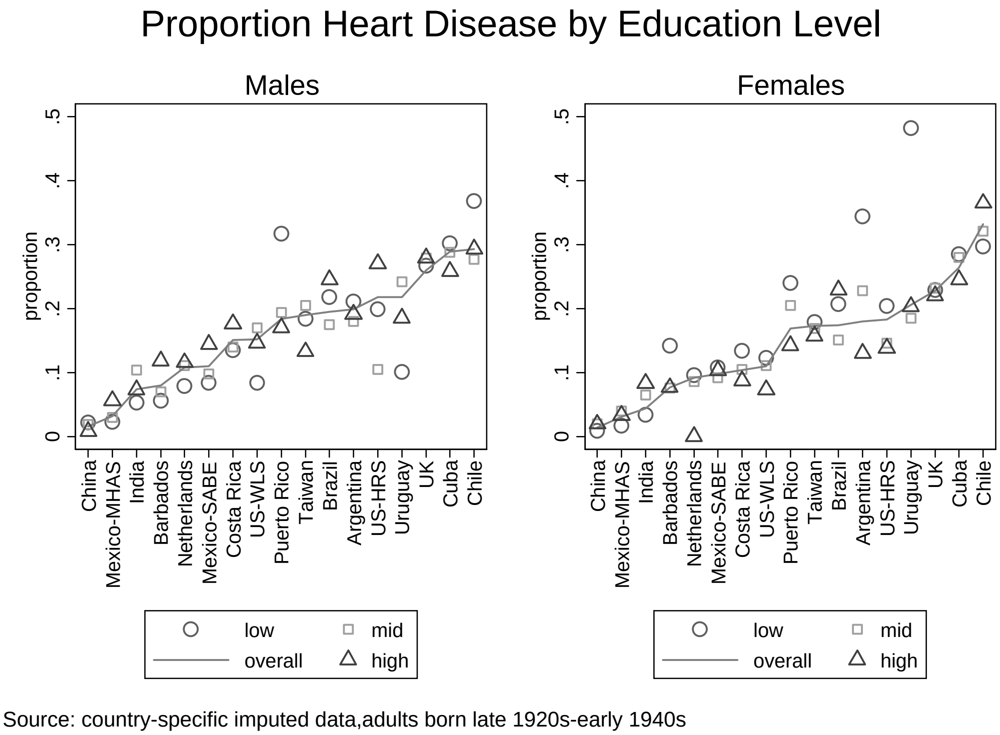
Table 4: Effects of income on adult health using pooled data

	Early Regimes	Mid-Paced Regimes	Late Regimes	Very Late Regimes
Heart Disease				
Lowest	1.02 (0.11)	1.09 (0.10)	1.06 (0.12)	1.14 (0.21)
Highest	0.85 (0.09)	0.90 (0.08)	1.14 (0.12)	1.23 (0.24)
Diabetes				
Lowest	1.12 (0.15)	1.14 (0.10)	1.01 (0.07)	1.10 (0.13)
Highest	0.93 (0.12)	0.94 (0.08)	0.87 (0.06)*	1.51 (0.17)***
Obesity				
Lowest	0.99 (0.13)	1.04 (0.08)	0.82 (0.05)**	0.69 (0.12)*
Highest	1.12 (0.14)	1.15 (0.09)	0.99 (0.06)	1.71 (0.27)***
Poor Self-Reported Health				
Lowest	1.42 (0.14)***	1.29 (0.10)***	1.41 (0.08)***	1.10 (0.06)
Highest	0.72 (0.07)***	0.61 (0.04)***	0.68 (0.04)***	0.81 (0.05)***
N observations	2992	4868	8427	9773

Notes: All of the models are unconstrained except heart disease and diabetes in the early regimes. Countries within regimes are: Early (Argentina, Uruguay, Cuba); Mid-Paced (Chile, Costa Rica, Puerto Rico); Late (Barbados, Brazil, Mexico); Very Late (Bangladesh, China, India, Indonesia). Constrained model best model (country coefficients assumed to be zero). All other models are unconstrained (i.e. country coefficients not assumed to be zero).

*p<0.05, **p<0.01, ***p<0.001. Using imputed country-specific data for those born late 1920s-early 1940s. All models also controlled for gender and age. In the case of unconstrained models, country dummies were also included in models. The number of observations may vary within regimes because in some cases there were no data on obesity (Argentina, Bangladesh), heart disease (Indonesia, Bangladesh), diabetes (Indonesia) or income (Taiwan).

Figure 1: Adult Heart Disease



Note: Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education.
All other countries: low (no schooling), mid (primary), high (secondary, plus).

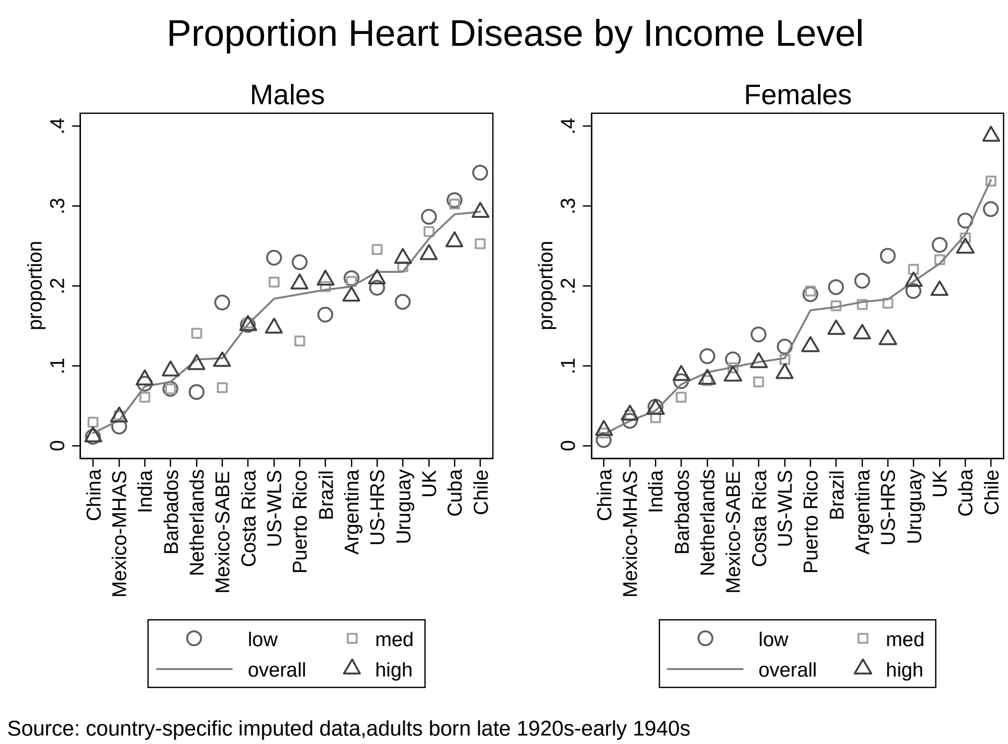
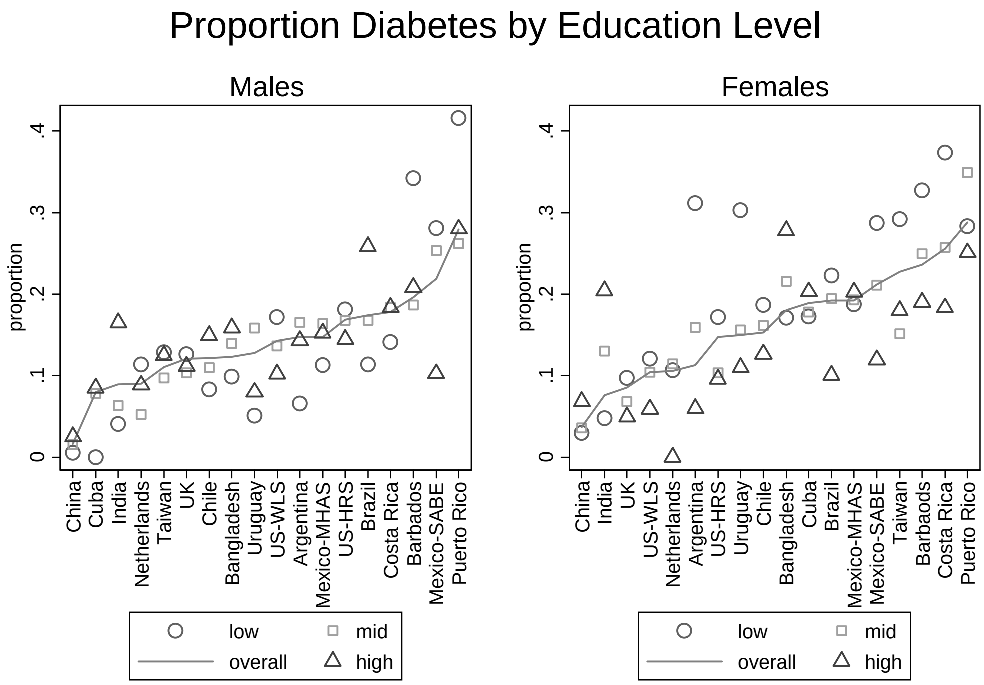
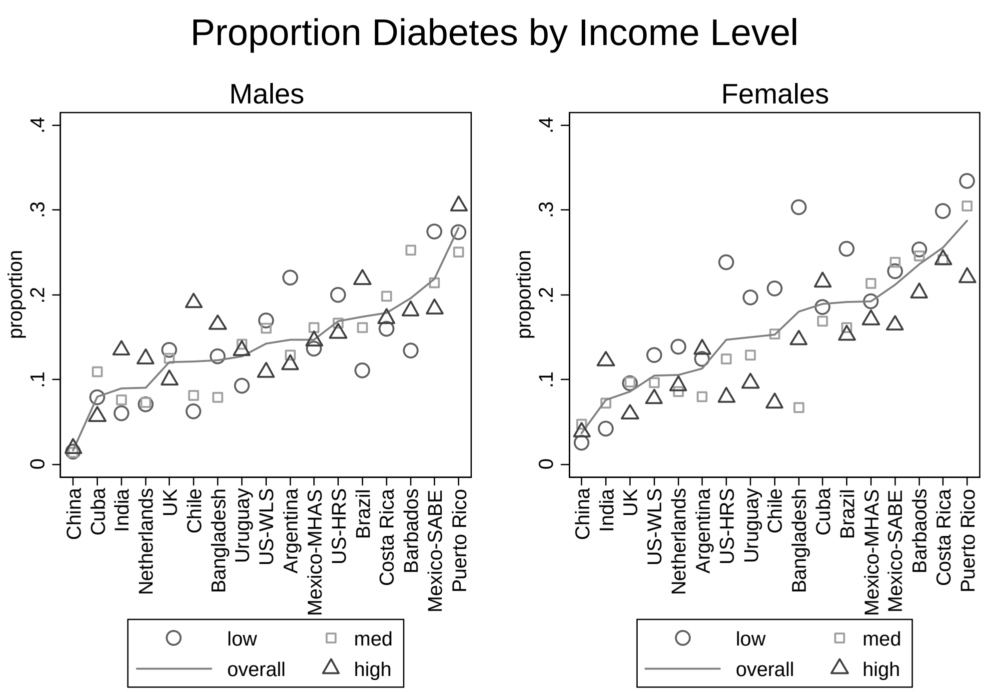


Figure 2: Adult Diabetes



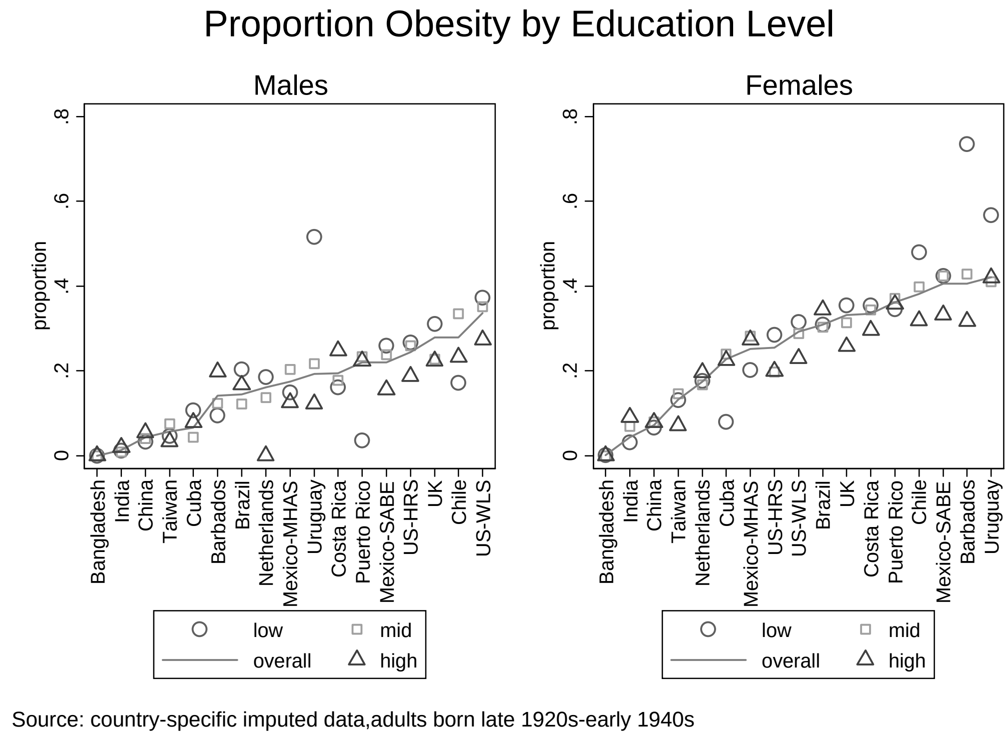
Source: country-specific imputed data,adults born late 1920s-early 1940s

Note: Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education.
All other countries: low (no schooling), mid (primary), high (secondary, plus).



Source: country-specific imputed data,adults born late 1920s-early 1940s

Figure 3: Adult Obesity



Note: Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education.
All other countries: low (no schooling), mid (primary), high (secondary, plus).

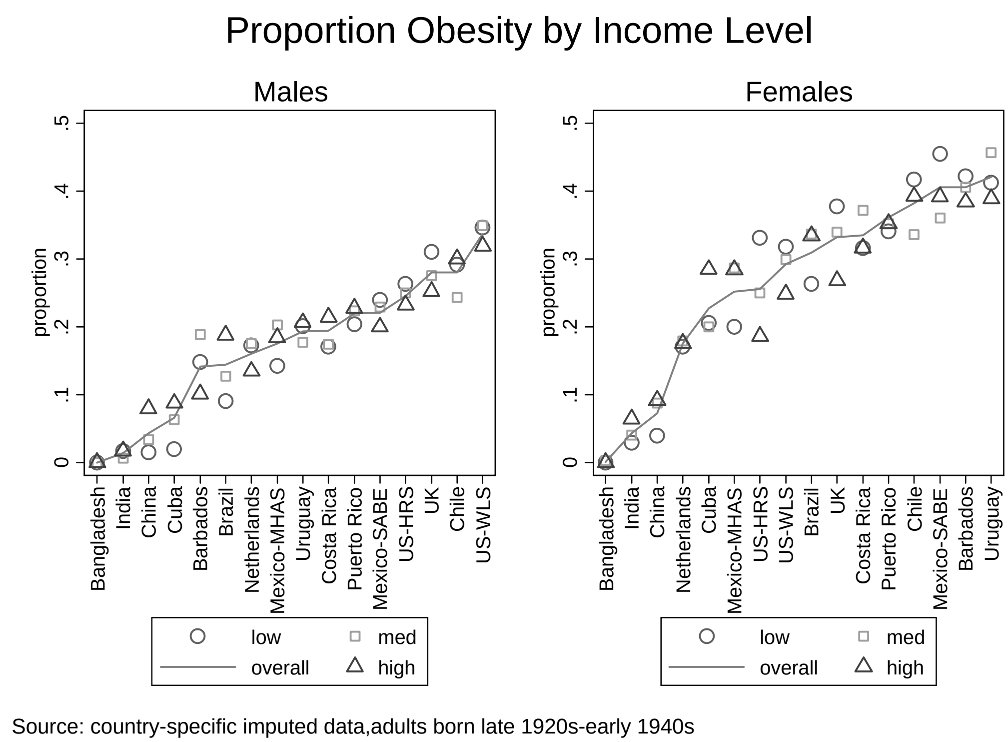
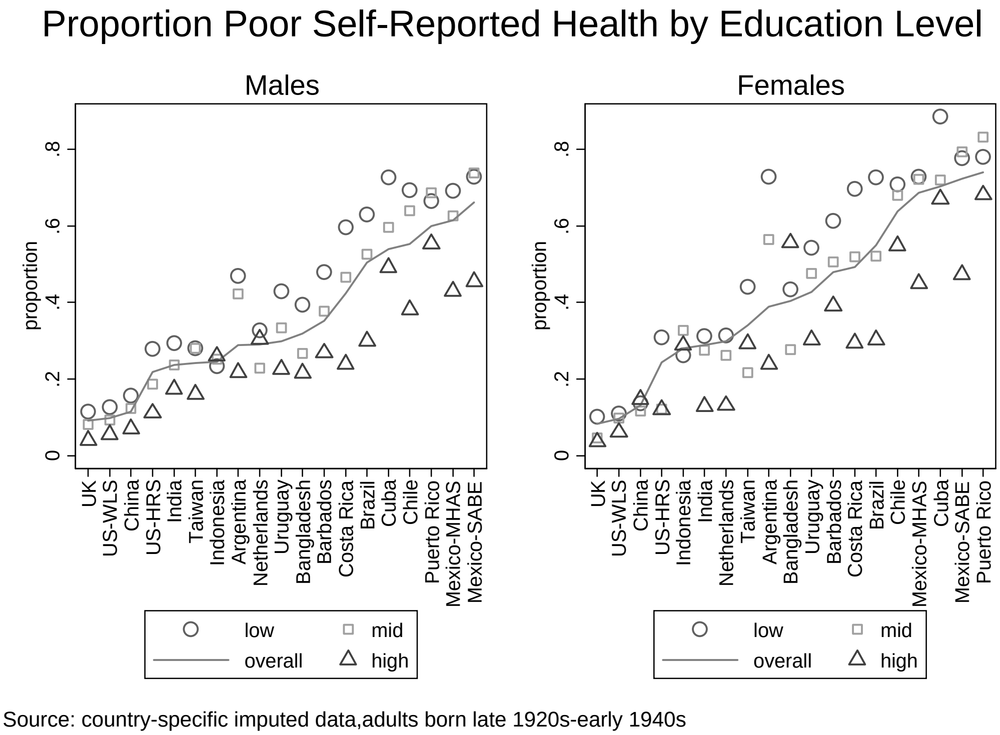


Figure 4: Adult poor self-reported health



Note: Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education.
All other countries: low (no schooling), mid (primary), high (secondary, plus).

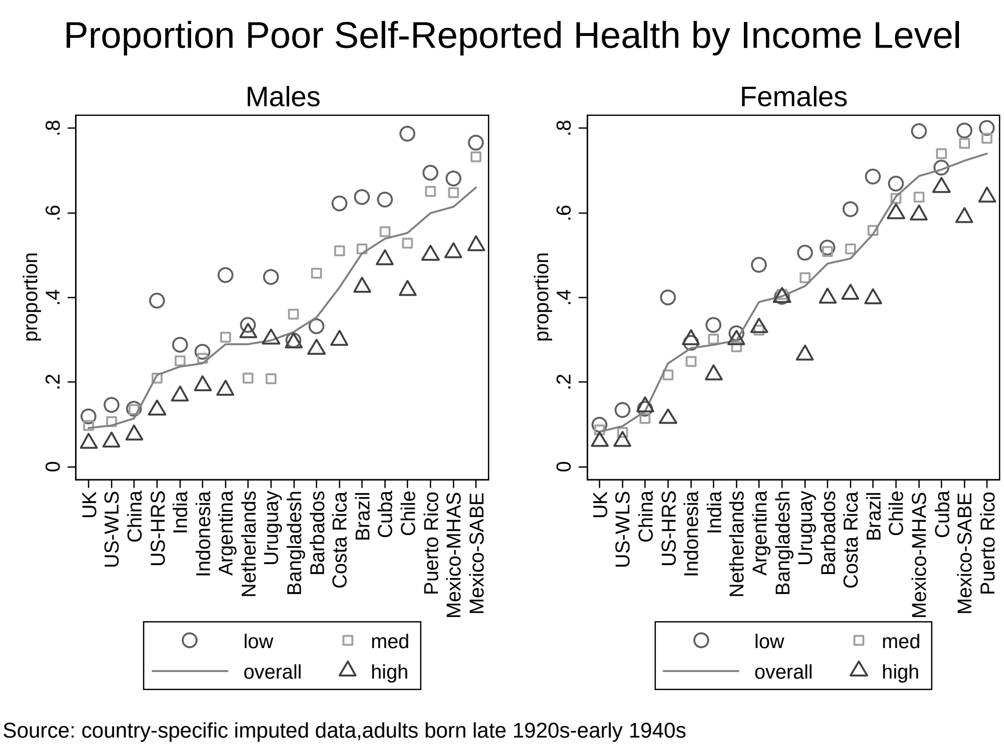
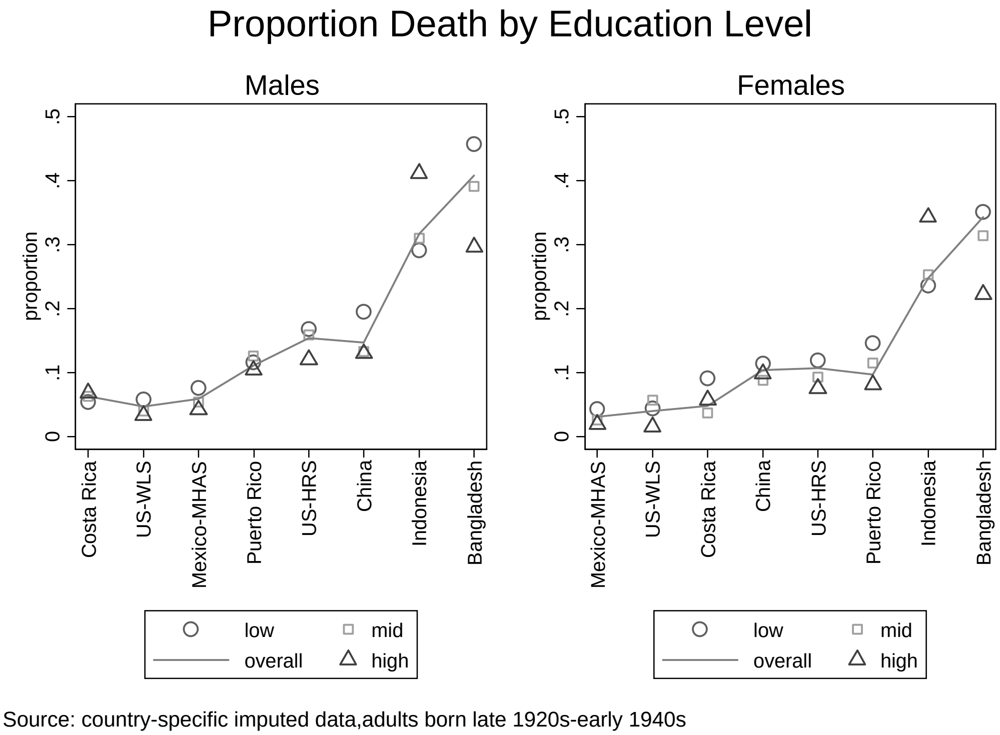


Figure 5: Adult Mortality



Note: Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education.
All other countries: low (no schooling), mid (primary), high (secondary, plus).

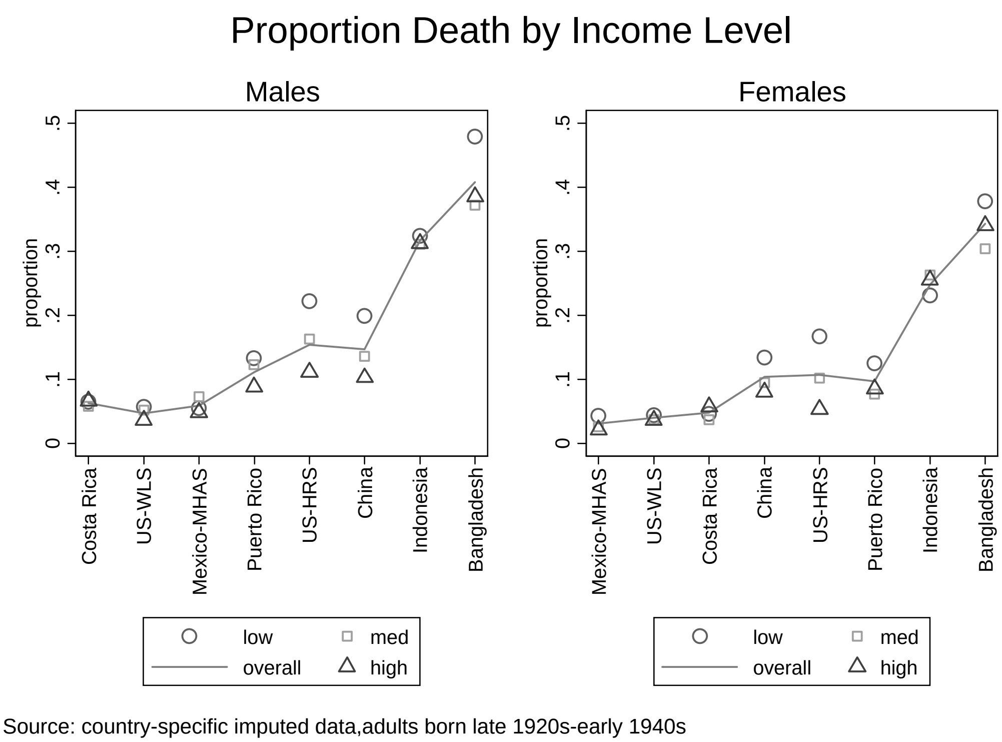
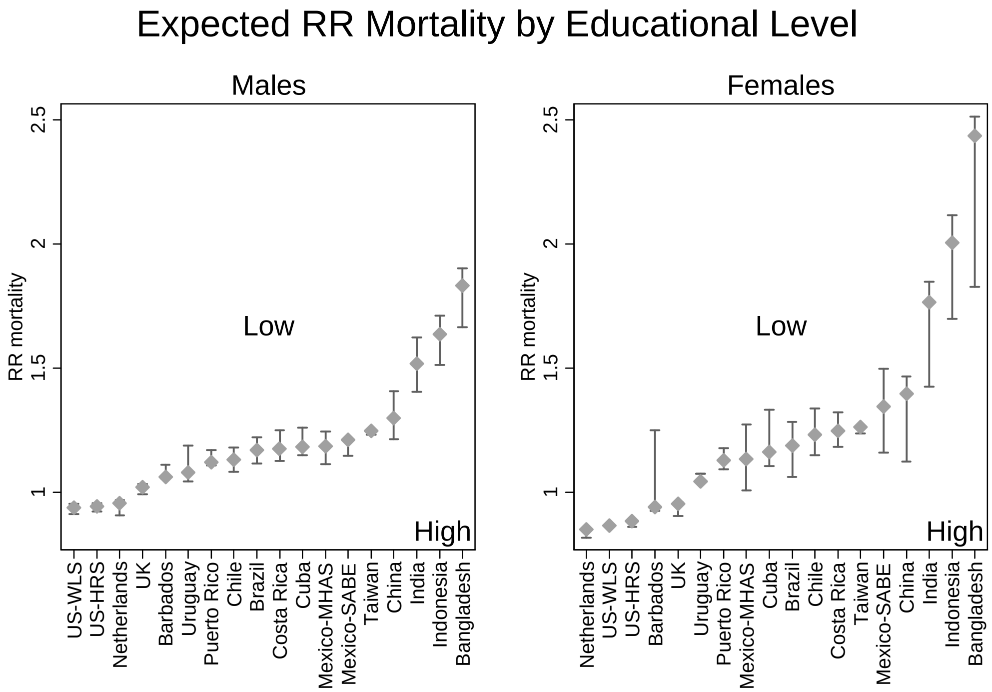
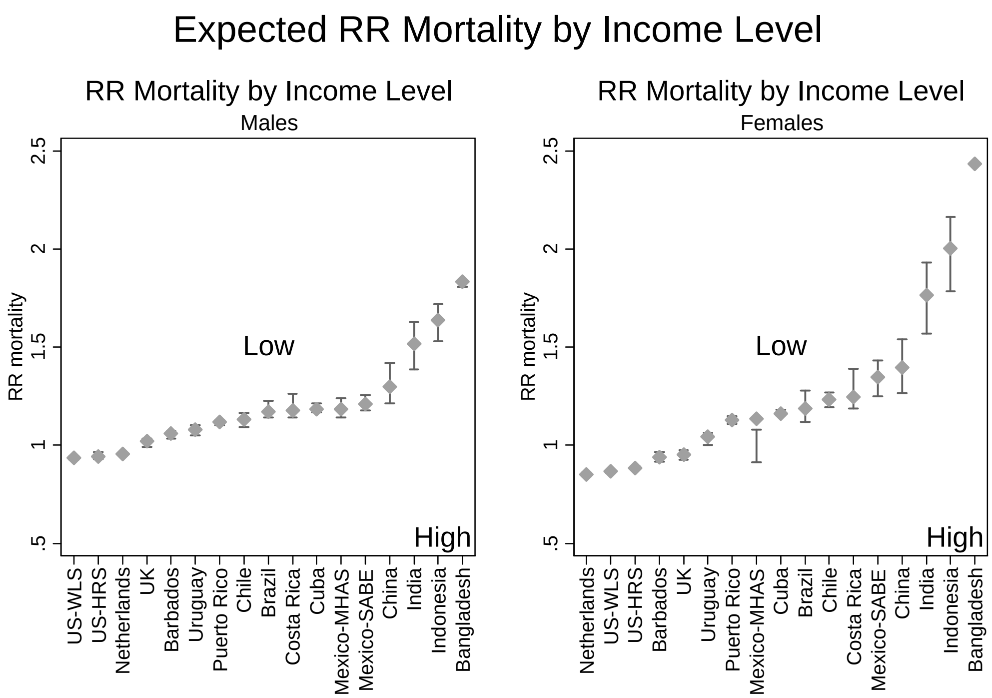


Figure 6: Relative risk of mortality



Top point: expected RR no schooling except UK,WLS, HRS,Netherlands 0-12 yrs



Top point: RR lowest tercile, middle point: RR overall, bottom point: RR highest tercile

Note: Numbers presented in graphs are based on Waaler-type relative risk mortality surfaces developed using Waaler data (1984). We estimated relative risk of mortality for each country using imputed overall average height and weight and averages by educational and by tercile of per capita household income. Educational levels: Netherlands, UK, US: low (0-12), mid (13-15), high (16+) years of education. All other countries: low (no schooling), mid (primary), high (secondary, plus).

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