Health among elderly Puerto Ricans: analysis of a new data set

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I. Introduction: background and scope of the paper

The main purpose of this paper is to test a conjecture and a handful of derived corollaries regarding the patterns of health and disability among elderly in Puerto Rico. Although the conjecture applies as well to countries of other parts of Latin American and the Caribbean, we focus on Puerto Rico since we are able to utilize richer materials recently collected through an island-wide survey. This choice is simultaneously a trap and an escape. It is a trap because the population history of Puerto Rico is somewhat unusual when compared with the experience of a typical country in Latin American and the Caribbean. This is mostly a result of unusually early fertility and, most specially, a mortality decline. Puerto Rico is in the same demographic league as Uruguay and Argentina, countries where, as we will see, the demographic preconditions are less favorable to the realization of the conjecture.

The escape consists in presenting us with a rude test: if we do not fail to reject the conjecture with an empirical case that does not present us with an ideal setting, its applicability to countries that manifest demographic profiles more consistent with the preconditions, although not totally assured, is more likely. Elsewhere we attempted with some success the verification of the conjecture with Mexican data (Palloni et al., 2003) and with data pertaining to a number of capital cities in Latin America (Palloni et al, 2002).

The core argument rests on a number of empirical regularities that characterize the landscape of aging in these countries. Section II describes these regularities and illustrates some of their manifestations in Puerto Rico. In this section we also spell out the main conjecture and derived corollaries. In Sections III through Section VII we present the materials for a proof suggesting that the original conjecture is likely to apply, albeit in a rather modified and weakened form. Although our conclusion is less strong than the original conjecture, it is thoroughly consistent with it and does not constitute an indictment of its accuracy. The unsatisfying aspect of our analyses is that they leave too many loose ends and multiple openings available: an escape using alternative explanations is not inconsistent with our findings. This uncertainty, we argue, is the inevitable result, of the vast chasm separating the ideal data required for precise verification and the materials actually available to us.

II. Not all aging is equal

Health status of elderly is but one among a handful of characteristics that make the aging process of the Latin American and Caribbean region a distinct one. There are a number of features that set it apart from others and that confer a singular character to an otherwise standard landscape of aging. They are potentially important for, even if verified only partially, they may generate a unique mixture of problems requiring vastly different policies from those undertaken elsewhere. In what follows we review a few of the most important features.

A. Speed of aging

The speed of demographic aging in Latin America and the Caribbean will be unprecedented. The time it will take a typical country in Latin America and the Caribbean to attain a substantial fraction of people above age 60, say around 15 percent, from current levels of around 8 percent is less than two fifths the length of time it took the US, and between one fifth and two fifths of the time it took an average Western European country to attain similar levels (Palloni et al., 2002; Kinsella and Velkoff, 2001).

The annualized rate of increase of the population older than 60 is approaching values as high as .045, implying doubling times of the order of 5 years for the next three to five decades. Barring unexpected demographic upheavals we should see that for the next three to five decades the speed of aging in the region will continue on a singularly fast course, a result of the momentum of demographic force set in motion long ago.

Much like Argentina, Chile and Uruguay and less like Costa Rica, Mexico, and Brazil, Puerto Rico's experience is somewhere in between that of the most extreme cases of rapid aging and the more relaxed and gradual schedule followed by the US and European countries. This is verified in comparisons of current and projected values of the total rate of growth of the population, the rate of growth of the population over 60 and estimates of the time it will take to attain a proportion of over 60 equivalent to about .20 in units of time equivalent to those of a developed country (Palloni et al., 2002; Kinsella and Velkoff, 2002)

B. Past population dynamic

Birth cohorts who reach age 60 and above after 1990 in the entire region are unique in that they are largely the product of medical interventions that increased childhood survival largely in the absence of significant improvements in standards of living. What is important to emphasize here is that this pattern holds true for the average country in Latin American and the Caribbean as well as for Puerto Rico: there is simply no difference in the first stages of the mortality transition between a typical Latin American country and Puerto Rico. Under US *aegis*, Puerto Rico experienced the effects of concentrated public health campaigns aiming at vector eradication, immunization as well as being a trying field for the diffusion of chemotherapy based on antibiotics (Vazquez-Calzada, 1988). A large fraction of the mortality decline that begins after its incorporation as a US special territory is attributable to these exogenous interventions sustained by medical innovations rather than to improvements in standards of living. At least initially, within ten or twenty years follow the transformation into a special territory, standards of living may have declined, a result of the devastation of the coffee based and local economy and its complete overhaul and organization around sugar exports.

It has been estimated that between 50 to 70 percent of the mortality decline that took place after 1940 in the region was associated with medical interventions and that the contribution of exogenous interventions to gains in survival is even larger for countries where the bulk of the mortality decline is attributable to the eradication of vector borne diseases, such as malaria and yellow fever (Palloni and Wyrick, 1981). The remainder of the decline was probably associated with better standards of living, increased knowledge about exposure and resistance to illnesses, and assorted other factors. Furthermore, it has to be remembered that, as was the case in Western Europe during the period 1750-1900, a large fraction of the initial gains in survival were concentrated early in the life of individuals, between age 1 and age 5 or 10.

C. The tug of the demographic past: contribution of mortality decline to the growth of the elderly population

The pattern of mortality decline described above has an important implication that is not well-known or, at least, well noted , in discussions of aging processes in developing countries. This is that the revolution that produced unprecedented gains in life expectancy half a century ago is a powerful driver of the current growth of the older population and will remain so for a time to come. To understand this we need a detour.

Just as the natural rate of increase expresses the proportionate change in the size of a population between two points in time, so age-specific rates of increase express the proportionate change of the size of the population in an age group between two points in time, t and t+dt. A number of inferences can be derived from this elementary fact (Preston and Coale, 1982; Horiuchi and Preston, 1988; Preston et al., 1989). For the purpose of this review, the most important regularities can be summarized thus:

$$R(60+, t) = r_B(60, t) - I(60, t) - J(60, t) \qquad (1)$$

and

$$RF(60+, t) = r(60+, t) - r(t) \qquad (2)$$

Expression (1) is for the rate of increase of the population aged 60+, R(60+,t). The rate is a function of $r_B(60, t)$, the rate of growth of births for the cohorts of births born between years (t-x) and (t+dt-x), I(60,t), the sum of differences between the age specific mortality rates from age 0 to age x experienced by the two cohorts and, finally, J(60,t) the sum of differences between mortality rates **above** age 60 for the cohorts aged 60+ at time t and cohorts aged 60+ at time t+dt.

Expression (2) is for RF(60+, t), the rate of increase in the **fraction** of the population aged 60+ or C(t). It is simply defined by subtracting r(t), the rate of increase of the entire population.

The most important consequence of (1) is this: upward pressure on the absolute size of the population 60+ during the time interval (t, t+dt) will occur due to any combination of three factors: cohorts reaching age 60 at time t experience improved mortality **before** reaching their 60^{th} birthday (increases in the probability of surviving to age 60), do so thereafter (increases in life expectancy at age 60) or, alternatively, the size at birth of the cohort that reaches its 60th birthday between t and t+dt is larger than the preceding one. J(60,t) is entirely due to changes in mortality conditions at older ages whereas I(60,t) is determined by improvements in mortality in early childhood and, to a lesser extent, by improvements in mortality at adult ages. Finally, $r_B(60, t)$ is solely dependent on *past* fertility. Instead, expression (2) suggests that the rate of increase in the proportion of the population above age 60 also depends on the total rate of increase of the population.

The key inference from these expressions runs counter to popular beliefs: it is that the demographic dynamics of the current and future elderly population is mostly a function of past developments in mortality and fertility and depends only partially and to a much lesser extent on mortality conditions at older ages and on current fertility. It is only the rate of growth of the *fraction* of elderly population that depends on current demographic parameters. The rate of increase of the elderly population, on the other hand, is entirely determined by past mortality and fertility changes and only marginally by changes in survival at older ages[1]. More concretely, the trajectory of R(60+,t) during the period 1990-2025, for example, will depend on three determinants:

a. **Determinant 1**, (r_B(60,t)): changes in fertility during 1930-1965;

b. **Determinant 2**, (I(60,t)): changes in mortality before age 60 during 1930-1965;

c. **Determinant 3**, (J(60,t): changes in mortality after age 60 during 1990 - 2025;

With a handful of exceptions, all countries in the region, including Puerto Rico (Vazquez, 1988), experienced high fertility levels (TFR above 5.0) on or before 1950, and large mortality declines beginning within the period 1930-1940, but particularly after 1950. Between 1950 and 1965-1970, and for reasons that are yet not altogether clear, some of these countries experienced moderate increases in fertility. Countries such as Argentina and Uruguay are oddities since they start out with relatively low levels of fertility (TFR's around 4). Puerto Rico is very similar to Chile, Cuba and Costa Rica where fertility begins to decline slowly between 1930 and 1940 but where the onset of large and massive drops in fertility occurs only after 1950.

Two consequences of these trends for the aging process are worth noting. **First**, cohorts attaining their 60^{th} birthday between 2000 and 2025 are inflated by the mild but ubiquitous surge of fertility of the years 1950-1970. Thus the rate of increase of the age group 60+ will increase in part because of these transient spikes in fertility levels (determinant 1). **Second**, and most importantly, cohorts that attain their 60^{th} birthday between 2000 and 2025 **are beneficiaries of unusually large improvements in**

[1] This statement is only accurate in societies that over the past 60 or so years have experienced drastic mortality changes at younger ages. It cannot hold for societies whose survival curve can only be modified by improving mortality at old ages.

survival, particularly during early childhood. Thus, for example, individuals born in 1960 experienced lower levels of early child mortality than those born in 1955. This will increase the relative size of the cohort attaining age 60 in 2020 relative to cohorts that reach age 60 in the year 2015 (determinant 2).

Based on adjusted historical series of birth rates and life tables, we estimate the magnitude of the component of growth of the population aged 60 and above associated with past mortality decline. Figure 1 displays the total rate of growth of the population over 60 and the amount of that attributable to cumulated changes in mortality before age 60 for cohorts that will attain age 60 during the interval 1950-2050. We estimate these quantities for Puerto Rico and Guatemala. The latter is a country which experienced a late demographic transition and opposes a stronger contrast to the demographic profile of Puerto Rico than any other country in the region could. Since the bulk of mortality decline, particularly during early childhood, occurs during the Post World War II years, the peak of rates of growth as well as of the contribution of cumulated mortality changes before age 60 are attained by cohorts born anywhere between 1940 and 1960, or those who begin to reach age 60 on or after 2000. The aftermath of the mortality decline will begin to be washed away only after 2010 in Puerto Rico and a decade later in Guatemala. Note that the contribution of mortality changes to the growth of the population older than 60 is substantial and exceeds 50 percent for several years after 2000. Most countries in the Latin American and Caribbean region will experience identical population dynamics.

[Figure 1 about here]

The main idea conveyed by Figure 1 is this: **a substantial fraction of future increases in R(60+,t) and, therefore, of the aging reflected in changes in the proportion of the population over 60 is attributable to mortality changes experienced during the period 1930-1990.** As shown elsewhere (Palloni and Lu, 1995), about 70 percent of this change is due to changes in mortality associated with parasitic and infectious diseases in the first ten years of life. This is a revealing statistic: **it suggests that the relatively compressed schedule of aging in the region can, in part at least, be traced to the medical and public health revolution that triggered the mortality decline nearly half a century ago**. This legacy of the past has implications for the health and disability status of the elderly after the year 2000.

D. The "stickiness" of early health status

So far we established two facts. First, that the aging process that Puerto Rico and other countries in Latin American and the Caribbean region will undergo during the period 1990-2050 owes significantly to the contribution of the mortality decline experienced during the period following 1930. Second, that the bulk of these mortality changes were due to the implementation and deployment of an assortment of medical innovations and public health interventions rather than, as was indeed the case among most developed countries (McKeown, 1976; Fogel, 1994; Fogel, 2003) to increases in standards of living or to improvements in levels of nutrition.

As a rule when mortality falls the surviving members of cohorts experiencing changes are of higher average frailty (Vaupel et al., 1979; Alter and Riley, 1989). This is purely an artifact of the changing composition by frailty and will tend to happen regardless of the origin of the mortality decline. However, the lives saved by the mortality decline in the region were certainly not random relative to conditions affecting health status. Indeed, they are more likely to have been drawn from populations exposed to higher risks, those whose morbidity and mortality experiences were dominated by parasitic and infectious diseases and lack of adequate early nutrition. Whenever the root origin of mortality improvements triggers increases in survival among those whose nutritional status and experiences with illness is worse than average the frailty composition of the corresponding cohorts will become less favorable than under a regime of survival gains that induces evenly spread mortality reductions.

Under the conditions described above, most childhood morbidity responsible for higher mortality *before* the interventions continued to affect children, albeit with reduced lethality. Thus, their influence and aftermath become shared by a growing proportion of survivors, mostly drawn from high mortality subpopulations. This has important implications *if early childhood conditions exert an impact on adult health and mortality*.

Suppose that conjectures 'a la Barker', those connecting early life conditions and late adult health status, are at least partially valid. According to these conjectures, detrimental conditions, including nutritional status and experiences with illnesses and faltering growth, which take place *in utero*, around birth and during early childhood, increase the susceptibility to certain chronic diseases during adulthood and old age.

Although evidence that early childhood conditions affects adult health is far from water-tight, it is clearly mounting fast and cannot be ignored. Empirical data as well as theoretical arguments (Elo and Preston, 1992; Schaffer, 2000) implicate a very broad array of mechanisms, from those involving latent effects (Barker, 1998) to those requiring circuitous pathways (Hertzman, 1994), critical periods (Barker, 1998; Cynader, 1994; Hertzman, 1994; Schaffer, 2000) or accumulation effects (Barker, 1998; Elo and Preston 1992; Hertzman, 1994). If any of these mechanisms turns out to have more than modest effects, increases in frailty among elderly whose earlier experiences fits the description provided above, are likely to be pronounced[2]. This means that the health status composition of elderly in Puerto Rico, Latin America and the Caribbean in general, should be worse relative to what would have been had the growth of the more recent and forthcoming cohorts of elderly been associated, as was the case in more developed countries, with improving standards of living. Our understanding of the relations between early childhood exposures and adult health status is still too primitive to enable us to establish precise predictions regarding the nature of expected health impairments. But this conjecture can at least be used as a guiding torch to explore the evidence available to us.

To summarize: given the nature of the mortality decrease in the Latin America and the Caribbean region one would then expect that the health status of a substantial fraction of those who will attain their 60th birthday after 1990 will be powerfully influenced by early life conditions, thus creating a pool of individuals more favorable to the expression of Barker-type of mechanisms and effects. In theory, the new cohorts of elderly will be of higher frailty than preceding cohorts whose early childhood experience is characterized by more severe mortality regimes. In addition, if there are strong connections between infant and child levels of malnutrition, experience with poverty and exposure to (and escape from) childhood illnesses, the new cohorts could be marked by higher than average exposure to some chronic conditions with late adult onset. If we are able to capture well socioeconomic conditions during early childhood, we should find large disparities by socioeconomic status. Finally, there should a strong relation between

[2] The argument holds, of course, if we assume that the effects of mortality selection are only mild and if the effects of changes in behavioral profiles and medical technology (exogenous or not) are only weak.

adult prevalence and indicators of early childhood conditions, particularly those associated with nutrition, growth and development and exposure to disease.

E. A new disease environment

There is a final feature worth mentioning since it complicates the picture even more. It is neither a mystery nor a novelty that the regimes of morbidity and mortality experienced by elderly people in developing countries are unusual. First, as one would expect (Omran, 1982) there is an expansion of chronic conditions, such as heart and lung disease, cancers, diabetes, and arthritis, and elderly people continue to be assaulted by significant levels of parasitic and infectious diseases (Frenk et al., 1991). We simply do not know what the health effects of exposure to highly interactive environments like these are. What should one expect, for example, under conditions where elderly people are simultaneously weakened by malaria and exposed to higher risks of congestive heart disease? Or, where increases in diabetes due to the adoption of a westernized diet (Popkin, 1993; Albala et al., 2000) are combined with recurrent intestinal infections and high prevalence of respiratory TB? What are the implications of a mixed mode of exposure for comorbidities, disability and impairments among the elderly? What are the implications for treatment? What effects does it have on demands for health care?

Admittedly this mixed mode of exposure is more prevalent in countries with a late demographic transition (such as Guatemala, Honduras, Bolivia, Peru, Ecuador) than in the more advanced countries of the region. Even though such regime is certainly not absent in the latter, it is likely to be less influential.

III. Synthesis of the conjecture and three derived corollaries

The main conjecture formulated above leads to several inferences. First, we expect that the characteristic pattern of elderly' health status in Puerto Rico and other countries of the region should be worse than what is observed in developed countries, even after removing the potential effects of **current** disparities in standards of living. Second, we should observe large socioeconomic disparities in health status and disability. Keeping everything else constant, social and economic disparities should be more salient in areas where the contribution of past mortality decline associated with deployment of novel medical technology is higher. Third, it must be the case that current health conditions, but particularly, the prevalence of certain chronic conditions is closely associated with past individual history, including nutritional status, experience with illnesses and overall socioeconomic deprivations experienced during early childhood.

To investigate the conjecture and corollaries we use preliminary data from a recently completed survey conducted with a nationally representative sample of about 4,500 elderly Puerto Ricans and their surviving spouses (PREHCO). By way of contrast, though not as a full object of investigation, we use information about Hispanics from HRS and NHIS, and from cross-sectional surveys of elderly population in seven capital cities in Latin America. We investigate age patterns of self reported health status, ADL and IADL among elderly Puerto Ricans and compare them to age patterns of self-reported health status, ADL and IADL among Hispanics living in the US, and elderly living in the seven capital cities in Latin America. We use information on selected chronic conditions, self reported diabetes and heart disease as well as anthropometric measures for the assessment of BMI, hip-to-waste ratios and knee height. These comparisons reveal that elderly Puerto Ricans residing in Puerto Rico are uniquely disadvantaged relative to elderly living in the US but, by and large, very similar to elderly people living in other Latin American and Caribbean countries who share with them a similar history.

We also investigate the relation between cardiovascular disease, diabetes and obesity, on the one hand, and conditions associated with early childhood (health status and socioeconomic conditions) while adjusting for the effects of age, gender and social class. Of special relevance to us is the relation between a marker of early stunting (knee-height) and the risk of obesity and of self-reported diabetes. We discover that short knee height entails a risk of adult diabetes that is almost as high as that associated with obesity, a somewhat surprising relation also present in some but not all elderly populations in other countries in Latin America. We interpret this finding as being consistent with the idea that there are links between conditions experienced in early childhood and the onset of some adult chronic conditions. We suggest that forecasts of health status distribution, healthy life expectancy and residual life expectancy and older ages ought to include consideration of the special character of cohorts who will become part of the elderly population in the near future. In the sections that follow we produce evidence partially supporting each of these corollaries for the case of Puerto Rico.

IV. Background, materials and methods

In this section we conduct a necessarily sketchy review of Puerto Rico demographic history and summarize the data sets we will use to attempt to falsify the main conjecture and its corollaries.

A. Background: a brief tour of Puerto Rico demographic history

There are three major differences between the population dynamic in Puerto Rico and that in other countries of the Latin American and Caribbean regions. The first is that from the beginning of the XXth century Puerto Rico has been swept by large outmigration flows, the most important of which are those destined to the US, first to Hawaii, then to New York and New Jersey. With the exception of the Cuban experience during the mid-fifties, nothing remotely similar has taken place elsewhere in the region. The second difference is that upon first contact with the US, Puerto Rico received a large infusion of public health interventions designed to eradicate vector borne diseases. The net consequence of this was to initiate a rather early mortality decline than pushed life expectancy from levels of about 30 years in 1900 (closely resembling those in other countries except Uruguay and Argentina) to values near 77 years in 2000. An important characteristic of Puerto Rico's mortality transition is that the initial decline stalled a decade or so after it began, surely as a result of fading returns from eradication campaigns, and was only resumed in earnest with the introduction of chemotherapy around the time of World War II. The early onset of the mortality decline makes the Puerto Rican experience very similar to that of Uruguay and Argentina, but its average pace resembles more that of the typical countries in the region.

Puerto Rican TFR in 1940 is estimated to have been around 5.60, not significantly different from levels in the non-Andean countries of the region for the same period. However, during the postwar period Puerto Rican fertility dropped sharply reaching values of around 2.04 in the year 2000. This decline occurs earlier than anywhere else (the exceptions, again, being Argentina and Uruguay), is sharper than those characterizing the most advanced demographic regimes in Latin American, and is accomplished through a combination of means that is somewhat unusual (except perhaps in Brazil) as it involves the heavy contribution of female sterilization.

Despite these differences, the demography of the aging process in Puerto Rico is roughly similar to the broad range of experiences undergone by a number of countries in the region. This is buttressed by, since it produces them, the similarities in patterns of growth of the population over sixty shown in Figure 1. Perhaps the only feature that could set the Puerto Rican experience apart from others is the potential influence of return migration from the US of elderly who left the island during their youth.

B. The epidemiological transition of the elderly

An important feature shared by the Puerto Rican demographic regime, and those being expressed in other countries of the region, is the rapid growth of prevalence of chronic conditions typically associated with the late stages of an epidemiological transition. In particular, most of these countries are in the midst of an as yet unfinished transformation about which we can only catch superficial glimpses rendered visible by statistics on causes of deaths. Universally, these patterns show the growing dominance of cardiovascular diseases, neoplasms and circulatory and cerebrovascular conditions. They also reflect the dramatic assault of metabolic disorders, in particular adult onset diabetes (diabetes II). Much, though by no means all, of the onslaught is experienced by the older population.

Figures 2a and 2b displays the crude death rates due to diabetes and heart disease for the population aged 55 and above. While the rates associated with heart diseases fluctuates and descend--as it has occurred elsewhere in the developed world and in some advanced developing countries--those associated with diabetes experience a sharp continuous and uninterrupted increase. As shown elsewhere, this is a feature common to just about all the countries in the region and appears to be commonplace in other developing countries (Popkin, 1993).

[Figures 2a and 2b about here]

As we will see, the elevation of the diabetes to the top cause of deaths among older adults is reproduced by its emergence as one of the two top conditions afflicting elderly in Puerto Rico and the region. It is also a disorder that, together with heart disease, has been tied to early experiences and will figure prominently in our attempt to falsify the main conjecture.

C. Description of data sets

To investigate the conjecture and associated corollaries we use several data sets. For Puerto Rico we use PREHCO, a recently completed survey of a nationally representative sample of the elderly population of the island. For Latin American countries we use SABE, a collection of seven surveys fielded among elderly people in six capital cities and one major metropolitan center. As contrast and representing populations in the developed world, we use the HRS/AHEAD survey as well as the 2002 NHIS and its Hispanic subgroups.

C.1. PREHCO

The Puerto Rican Elderly: Health Conditions (PREHCO) project was designed to gather quality baseline data on issues related to the health of elderly Puerto Ricans. The data collected offers a substantial amount of information within the limits permitted by face to face interviews in a cross section.[3] PREHCO is a cross-sectional survey of the non-institutionalized population age 60 and over and their surviving spouses who were resident of the island as of June 1st, 2000. The sample is a multistage, stratified sample of the elderly population residing in Puerto Rico with oversamples of regions heavily populated by population of African descent and of individuals aged over 80. The data was gathered through face-to-face interviews with elderly adults, including those with cognitive limitations who required the presence of a proxy to provide information, and with their surviving spouses, regardless of age. The field work consisted of interviews conducted with laptop and specialized anthropometric measurement and physical performance. More than 20,600 households were visited in 233 sample sections. A total of 4,293 in-home face-to-face target interviews were conducted between May 2002 and May 2003, averaging 114 minutes in length. In addition 1,444 spouses were interviewed, 1,043 of them 60 or older. The fraction on interviews requiring a proxy was 12.4%. Only 4.7% refused to participate and the overall response rate was 93.9%. The questionnaire includes modules on demographic characteristics, health status and conditions, cognitive and functional performance, labor and economic status, income and assets, health insurance and use of health services, family structure, intergenerational transfers,

[3] The study, a joint venture between the Center for Demography and Ecology of the University of Wisconsin-Madison and the Graduate School of Public Health of the University of Puerto Rico, funded by the National Institute on Aging and supported by the Legislature of Puerto Rico, is the largest ever about the elderly population in Puerto Rico.

housing, anthropometric measurements and physical performance. Basic information is displayed in Table 1.

[Table 1 about here]

C.2 SABE

SABE (SABE, 2003) is a data collection project anchored in seven major cities (six of them capital cities) of the region: Buenos Aires (Argentina), Bridgetown (Barbados), San Paulo (Brazil), Santiago (Chile), Havana (Cuba), Mexico City (Mexico) and Montevideo (Uruguay). All seven surveys were administered to representative samples of populations aged 60 and above in each city and were strictly comparable though translated to three different languages (Spanish, Portuguese and English). In some cases, interviewers selected a target older person and his/her surviving spouse. All sample frames were drawn either from recent population censuses or from nationally representative surveys carried out periodically in the capital cities of the region[4]. The fieldwork took place between June 1999 and June 2000 and a preliminary final report was completed in December of 2002. An important feature of the survey is that, with one exception (Buenos Aires), the rates of response were significantly higher than those in similar surveys in other countries. Table 2 displays basic information on sample sizes, rates of response, as well selected dimensions of the demographic profile (composition by age, sex, marital status, race) and of the socioeconomic composition of the samples (by education). As shown elsewhere the basic demographic profile accords well with national figures[5] [6]. Table 3 displays information on a few health-related characteristics that will be the object of study in this paper, namely, self reported health status, Activities of Daily Living (ADL), Instrumental Activities of Daily Living (IADL), chronic

[4] See more information on the nature of the samples (Pallani and Palaez, 2002).

[5] Because all samples are urban samples, our ability to generalize to the total population is impaired. However, readers should bear in mind that the proportion of the total population living in urban areas in these countries is substantial, varying from close to 100 percent in Barbados to about 74 or 75 percent in Mexico and Cuba respectively (United Nations 2000). This suggests that our results should not be too different from what we would have obtained had SABE been based on national samples. And, indeed, it has been shown that the demographic profile at least of the samples is quite close to national averages (Palloni and Pelaez, 2002).

[6] In the rest of the paper we refer use the words "country" or "city" to refer to the **city samples**. By using the word country we are in no way assuming that the SABE data are exactly representative of elderly populations in each of the countries who participated in the project.

conditions, and anthropometric measures[7].

[Tables 2 and 3 about here]

C.3. HRS and NIHS

The University of Michigan Health and Retirement Study (HRS, 2000) surveys more than 22,000 Americans over the age of 50 every two years. The study paints an emerging portrait of an aging America's physical and mental health, insurance coverage, financial status, family support systems, labor market status, and retirement planning. The sample we used in this paper included 12,527 target respondents (no spouses) aged 60 and above.

The National Health Interview Survey (NHIS) is a cross-sectional household interview survey conducted annually since 1957 by the National Center for Health Statistics (NCHS) on representative samples of the civilian non-institutionalized population of the United States. Since 1995, the sample design was adapted to allow oversampling of both Black and Hispanic persons. We use the most recent dataset available to compare the health of persons of Hispanic origin 60 years old or older living in the US to the health of Puerto Ricans elderly living on the Island. The NHIS questionnaire contains three modules: a basic module, an adult core, and a child core module. We use the adult core questions with the same wording as those selected for analysis from the PREHCO questionnaire except for two items. First, self-rated health in NHIS refers to present health status of the respondent compared to a year ago rather than to a scaled self-assessment of present health condition as is the case in PREHCO. Second, NHIS questionnaire provides a question about presence of any functional limitation without specific reference to ADL or IADL limitations. From the original 2002 sample composed of 29900 adult males and females, we extract a sub-sample of 4543 women and 2898 men 60 years old or older including Hispanics, non-Hispanic blacks, and non Hispanic whites with the following distribution: 463 and 276 female and male Hispanics, 543 and 312 female and male non-Hispanic blacks and 3537 and 2310 female and males non-Hispanic Whites. The figures are weighted to account for the sampling scheme and

[7] The definition of ADL, IADL, and self-reported conditions selected for study in this paper have been reported elsewhere. They are strictly comparable to those used in other surveys of elderly, particularly the Health and Retirement Survey (HRS) (Health and Retirement Study, 2000).

other adjustments. The data are collected through a personal household interview and one adult per family is randomly selected for the interview. The selected interviewees respond for themselves (without aids from proxies) to the questions in the adult sample questionnaire.

V. Health status of elderly Puerto Ricans in perspective: descriptive results

We begin with a descriptive assessment of health outcomes including poor self-reported health, functional limitations and chronic conditions (in particular diabetes) by age and gender, and by socio-economic standing. Our main goal in this section is quite modest, namely, to make at least a weak the case for the argument that health status among elderly Puerto Ricans is close to that of countries in the region with a similar demographic trajectory--that is, those where the demographic dynamic of aging is fed by similar process.

There is solid evidence suggesting that *self-reported health* is an indicator of general health with good construct validity (Smith, 1994; Manton et al., 1997; Soldo and Hill, 1995; Wallace, 1995), and is a respectably powerful predictor of mortality risks (Idler and Benyamini, 1997; Idler and Kasl, 1991), disability (Idler and Kasl, 1995) and morbidity (Beckett et al., 2000; Schechter and Beatty, 1998) though these properties vary somewhat with national or cultural contexts (Idler EL, Benyamini, 1997). Self reported limitations in Activities of Daily Living (***ADL's***) or Instrumental Activities of Daily Living (***IADL's***) are a mainstay of population-based information on disability and latent demand to support and assistance. In addition, ADL and less so IADL can be considered as trailers of past or current comorbidities and are thus an indication, albeit ambiguous, of presence of illnesses. Finally, we also compare the frequency of chronic conditions self reported by respondents, a comparison which is subject to all the caveats appropriate to self-reported morbidities and, in particular, we focus on patterns of self-reported diabetes, obesity and heart disease.

A. Self-Reported Health Status

Figure 3a displays the proportions reporting their health as "bad "("mala") by age groups for PREHCO. As a contrast we have included estimates for elderly aged 60 by gender and age group for all seven SABE cities separately and for participants in the Health and Retirement Survey (HRS). The **first** feature of the graph is the massive intercountry heterogeneity which completely overwhelms the effects of gender and age. PREHCO's population has higher proportions of individual self-reporting in bad health (16 percent) than in HRS and than four of the seven Latin American cities. The lowest proportions are observed in the SABE cities of Buenos Aires, Bridgetown, and Monetevideo (5 to 7 percent). These cities are in countries that, perhaps not coincidentally, are those which until the beginning of the XX1st century enjoyed highest standards of living (as measured by GNP per capita). They are also those with the most modern demographic regime, with near replacement fertility and life expectancies at birth exceeding 75 years.

[Figure 3a about here]

The **second** feature is the age and sex patterns of self reports. By and large we observe increasing proportions in bad health with age for PREHCO, HRS and for SABE. The only exception to this regularity is in Mexico City where the age pattern is flat. The sharpest increase always occurs after age 70 and is particularly pronounced in all populations except in Chile. Females do worst than males everywhere, (a recurrent finding with data of this type), although differences do not appear to be very pronounced in PREHCO data. The Latin American and Caribbean region is no different than others in this respect.

A **third** feature is that elderly living in the SABE cities with the best standing (Buenos Aires, Bridgetown and Montevideo) are equally or less prone than those in the US to report their health as bad, while elderly living in Puerto Rico and the SABE cities of Santiago, Havana and Mexico City are considerable more likely to do so. Elderly in the US are in an intermediate position between these two extremes.

Measured by most conventional indicators, Puerto Ricans enjoy and have enjoyed for a long time better standards of living that most of the countries in the region. It is because of this, and even despite the fact that many caveats should prevent us from reading too much from the ordering of items contaminated by a fair amount of cultural idyosincracies, that we find somewhat surprising that PREHCO self-reported health status ranks among the worse in the region.

In sum, age-gender patterns of self-reported health among elderly in Puerto Rico are very close to those observed in countries in Latin American and the US but the levels of self-reported bad health are on the high end of the spectrum.

B. Functional Limitations

The age patterns of the proportions with at least one ADL and at least one IADL are displayed in Figures 3b and 3c. The PREHCO elderly population exhibits similar age-gender patterns than SABE and HRS with the sole exception of the last two age groups for ADLs. There are strong age gradients, important gender differences, but virtually no intercity heterogeneity among SABE cities. The older population in PREHCO exhibits weaker age gradients for ADLs, less pronounced gender differences than any of the other populations considered here and, suspiciously, the lowest levels of all. By and large, elderly in the US fare equal or better in terms of ADL's than most of the other populations considered here, except Puerto Ricans.

Surprisingly, the obverse results are obtained for IADLs: while the elderly population of HRS experiences the lowest levels of IADL's , those of SABE and PREHCO in particular, show the highest levels. Other features, such as the age and gender differentials are identical to those manifested by ADL. The inversion of levels for ADL and IADL for PREHCO is somewhat puzzling but may be explained by the existence of conditions that while not imposing severe physical limitations do impede activities tapped by IADL's. [8] This interpretation, however, is inconsistent with the relative high mean number of chronic conditions in PREHCO (see below).

[Figures 3b and 3c about here]

C. Chronic conditions.

Figure 3d displays the mean number of chronic conditions by age and gender and shows that, as was the case for ADL and IADL, the overall age patterns slope upwards and females tend to do worse than males in all countries. Excluding Cuban females, the intercountry heterogeneity in the SABE sample is remarkably small. The populations of the US and PREHCO, on the other hand, stand out for their high mean number of self-reported chronic conditions at all ages. Indeed, a simple comparison shows that the elderly population of HRS exhibits a higher average number of chronic conditions than

[8] We do not exclude the possibility of cultural biases that may constrain refusal to acknowledge lack of autonomy in certain realm of private life while permitting free expression of lack of independence in others. But if so it is utterly incomprehensible how such bias will be present in Puerto Rico and not in the other countries of the region.

PREHCO and that *any* of the countries in the SABE sample (except Cuban females). PREHCO males are more similar to HRS males in the younger age groups than are SABE cities. Why should this pattern of differences in the mean number of chronic conditions prevail? One explanation is that differences in access to health care services may lead to more undiagnosed conditions in countries of the region than in the US and Puerto Rico. Since self-reporting of conditions is not an indication of severity, the disparities could simply reflect the existence of a diagnosis. A second explanation is that heavier selection induced by excess mortality among those with higher number of conditions leads to a surviving population with a lower mean number of conditions. But we have little evidence to confirm this speculation since, although we know approximately what the overall ranking by countries of adult age mortality levels is, we know nothing about mortality differential by number of chronic conditions

[Figure 3d about here]

D. The dominance of diabetes and heart disease

We showed that Figure 2a documents one dimension of a new epidemiological regime to which older adults are exposed, one where chronic conditions dominate over infectious and parasitic diseases. In our descriptive review of health status in section C we obliquely referred to the fact that the information available to us from various countries in the region and from Puerto Rico in particular suggests elevated levels of both diabetes and of its main risk factor, obesity. In this section we propose to examine these patterns while trying as a prelude to the attempt to find a connection to early childhood conditions. We focus on two diseases, diabetes and heart disease and on one risk condition, obesity.

D.1. Diabetes, obesity and heart disease[9]

Figures 4a and 4b display respectively the proportions of individuals by age groups and sex who self-report having being diagnosed with diabetes and who are obese

[9] We classify as obsess a person whose Body Mass Index (BMI=weight/height^2) is greater than or equal to 30.

for PREHCO, all SABE cities and HRS[10]. Elderly in Puerto Rico have much higher rates of self reported diabetes than either SABE or HRS. The pattern by age is sharp and quite similar across countries, concave downward with a peak around 70-74[11]. With the exception of PREHCO, males are less likely to report diabetes than females. For the most part, elderly individuals in HRS are as likely as the average individual in the pooled SABE sample to report diabetes. The fact that Cuba exhibits very low levels of self-reported diabetes specially among males, is curious and some would attribute it to the fact that the adoption of a Western life style has simply not been an option in this country and, therefore, the risk factors associated with a new diet and sedentary life styles are simply absent. To explain the very high levels in Puerto Rico (as well as Barbados, Brazil and Mexico) one probably needs to invoke a combination of explanations. One may be sustained by reference to the ethnic composition of these populations: Puerto Rico, Barbados and Brazil, after all, have a hefty component of population with African descent whereas Mexico has the highest percentage of indigenous and mestizo population. This type of explanation must remain a conjecture until we are able to verify that within-country differentials in Barbados, Puerto Rico, Brazil and Mexico at least are explained by ethnicity rather than by other conditions. The second type of explanation could be erected on a foundation linking diabetes and early childhood conditions. While our examination of the evidence shows that this is a very plausible accounting for Puerto Rico (see below), the evidence is far from uncontroversial in the remaining three countries (Palloni and McEniry, 2004)

Figure 4b reveals that PREHCO population stands out again as the one with the highest risk of obesity among males and nearly so for females as well. This is consistent with patterns of diabetes prevalence as obesity is one of the most important risk factor accounting for the metabolic disorder.

Finally, Figure 4c displays patterns of self-reported heart disease. By and large, probabilities of self reporting this set of conditions increase with age and are roughly similar for males and females. Male and female elderly in Puerto Rico (as well as in

[10] Self-reported diabetes is not perfect. We know that it underestimates true prevalence. But it is quite accurate as it has very high specificity but lower sensitivity in very different cultural contexts (Palloni et al., 2003; Goldman et al., 2002).
[11] The declining pattern with age is probably a result of the heavier attrition of diabetics as age increases.

Chile) exhibit the highest levels of self reported heart disease whereas Mexicans in Mexico City and US elderly experience first and second lowest levels of heart disease respectively.

[Figures 4a-4c]

E. A compact summary of results

The findings described above can be more compactly summarized in the form of simple regression models where all the data sources are pooled and we attempt to assess additive (and interactive) effects of discrete variables that proxy for data sources. The idea is to summarize the distinctiveness (if any) of PREHCO population with regard to the health outcomes reviewed before. Table 4 displays the estimated effects of belonging to one of the populations examined here on the log odds of experiencing bad health (self reported), at least one ADL, at least one IADL, and self-reported diabetes. All estimated models are logistic and include minimal controls for age and sex. The table confirms and highlights a pattern identified by the figures, namely, that the elderly population in PREHCO ranks among the three worst in terms of self reported health status and IADL's but is somehow blessed by very low levels of ADL's. The fourth column of Table 4 confirms the visual impression and singles out the unique pattern of high self-reported diabetes in Puerto Rico, followed by Barbados, Brazil and Mexico. As expected, the effects on the log odds of self reporting diabetes in Puerto Rico are very large (a whooping 1.10 with p<.00000) relative to a country such as Uruguay. The differences in effects between pairs of country including PRECHO and any of the others (except Barbados, Brazil and Mexico) are highly significant. Similar results apply for obesity (not shown). Finally, the last column of Table 4 underlines the outlying character of HRS and PREHCO regarding the mean number of self-reported conditions as they are associated with .41 and .17 additional units or about 33 and 28 percent more over the observed inter-population average respectively.

[Table 4]

F. Are Puerto Ricans any different than elderly Hispanics living in the US?

The foregoing comparisons contrast the PREHCO elderly population with Hispanic populations in Latin American and with the total HRS population. While informative this latter comparison may me insufficient at best and misguided at worst.

Perhaps a more useful contrast for us is with the Puerto Rican elderly population living in the US. After all, the conjecture applies all the same to individuals who remained in the island and to those who migrated for work reasons during their early adulthood years. Unfortunately neither HRS nor NHIS (or any other available sample of US elderly) includes a sufficiently large number of Puerto Ricans to permit comparisons. So, we opt for a comparison with the entire Hispanic elderly population living in the US. The caveat is obvious: most Hispanic elderly living in the US are of Mexican, not Puerto Rican, origin and although their conditions may be similar their experiences both early during life and throughout their residence in the US are quite different.

Figures 5a-5f display figures representing proportions self-reporting in bad health, with at least one ADL, with at least one IADL and the mean number of chronic conditions in PREHCO and in the Hispanic populations found in HRS and NHIS 2002. Perhaps the most remarkable feature revealed by these graphs is the similarity in levels, age and gender patters. Here again it is the reporting of very low ADL's in PREHCO that provides the exception to the rule. Differences between prevalence of IADL, on the one hand, and HRS and PREHCO, on the other, may be entirely explained by lack of comparability between items. But the similarity in self reported health and mean number of chronic conditions, however, is remarkable.

[Figures 5a-5f about here]

VI. Socioeconomic gradients among elderly in Puerto Rico

One of the corollaries stated before involves the existence of strong gradients by socioeconomic status. Indeed, if deleterious early childhood conditions do indeed affect health status during adulthood, we would at least expect that individuals who belong to more privileged social groups would be less affected by the peculiar evolution of mortality trends early during the century, and should experience a more favorable profile than those in less privileged social positions.

But while verification of gradients is a necessary condition to establish the massive influence of the secular mortality decline on health status conditions of the current elderly population, it is not sufficient. This is because the presence of steep gradients is also compatible with the absence of such influence and the presence of alternative mechanisms. But at least we are able to show that socioeconomic gradients are large where they are expected to be according to the conjecture.

Although PREHCO, as does HRS, includes measures a very complete battery of indicators of assets and wealth, the data are too preliminary for us to employ the variables currently available. In their place we choose to focus on socioeconomic status as assessed by educational attainment and family. We estimate average levels of education (income) among groups of people defined by a targeted health outcome. If socioeconomic gradients are important, they will be manifested by a clear, marked slope in the average levels of education (income) across health outcomes.

Figure 6 graphically displays the aggregate association between income and selected health outcomes. The gradients associated with education are strikingly similar, and we do not show the associated graphs. Whether one uses education or income the slopes of gradients are in the expected direction. For the most part they are quite sharp, regardless of health outcomes but there appears to be a hierarchy as inequality by income or education is more pronounced for self-reported health, ADL and IADL, in that order, and least pronounced for diabetes obesity. In some cases (diabetes) inequalities are fairly trivial. What is truly remarkable is the across-the-board homogeneity in gradients for all health outcomes. If one abstracts from level differences, it is virtually impossible to tell populations apart. Perhaps the only notable exception is Cuba, the country that exhibits the lowest levels of inequality across quintiles of income and education categories, regardless of health outcome. The elderly in Puerto Rico do not stand out in any particular realm although they do exhibit higher levels of income inequality in ADL and IADL.

[Figure 6 about here]

The patterns revealed by Figure 6 can be captured more parsimoniously through simple regression analyses. We estimate discrete logit models for each of the health outcomes of interest. We pool all the individual records across all data sets and estimate logistic models for each of the health outcomes of interest controlling for age, gender and population of origin (or data set) while simultaneously estimating the effects of income (or education) and of the interaction of income (education) and population of membership. The latter are variables designed to test the null hypotheses of no differences in income (education) effects across populations. Table 5 displays the most important results for income and education. The first panel shows that while the additive effects of poverty (being in the first quintile of the country-specific income distribution) on the log odds of health outcomes are properly signed, large, sustained, and statistically significant (first row), they are **not larger among Puerto Rican elders than anywhere else**: indeed, all the interaction terms displayed in the second row are all statistically insignificant. The same inferences can be drawn if we use education instead of income. In fact, the second panel shows that the additive effects of having a level of education equivalent to primary or less are properly signed, statistically significant and quite large (first row) but the interaction effects suggest that Puerto Rican education gradients are just about the same magnitude as everywhere else.

[Table 5 about here]

In summary, while examination of socioeconomic gradients confirms the existence of sharp inequalities by socioeconomic status, it does not reveal any indications that the conjecture stated before applies and that the mechanisms invoked by it could produce these inequalities. If this were so, Puerto Rican elderly (and others whose demographic origin is similar) would experience levels of inequalities quite above the average. They do not.

This negative conclusion, however, is perhaps excessively defensive and conservative. Part of the problem, of course, is that the indicators of wealth and assets in infancy and childhood can be only superficially tapped by those we used in the aforementioned examination. There are two additional reasons for taking this preliminary conclusion with some skepticism. The first is that similar levels of inequalities can conceivably be produced by completely different mechanisms so that observed uniformity when one does not expect it does not necessarily imply absence of the suspected cause. The second reason is that what we observe is inevitably the result of the combination of a prevalent causal mechanism (for example, the influence of early childhood conditions) with those that select survivors among those exposed to the mechanism. Take, for example, the case of diabetes. The notorious flatness of the gradient is probably not due to the fact that the prevalence of diabetes does not vary by social class but rather to the confounding influence of selective survival of diabetics across different social classes.

VII. Diabetes, obesity and heart disease in Puerto Rico: a legacy of the past?

Our final analysis is designed to identify direct evidence of a relation between early childhood conditions and adult illnesses. In particular, we seek to identify linkages between current health status and early exposures. This is a necessary condition for the conjecture to be true: if no relation between the remote past and current health status is uncovered, it cannot be the case that the aging tide traceable to the mortality decline of the forties and fifties has in any way affected the health status composition of elderly other then through routine changes in the distribution by frailty. But it is not a sufficient condition for, if the linkage does indeed exist, it does not necessarily mean that we would not have observed it had the mortality decline been caused by forces other than those identified before. In other words, we could have observed at least some linkages even if the mortality decline had been completely rooted in better nutrition, for example. Thus, we can only provide weak proof of the conjecture.

We pursue two complementary verification strategies. The first relies on the hypothetical connection between adult physical characteristics, early childhood nutritional status, and adult health conditions. The second exploits information elicited from PREHCO's respondents about their health status and socioeconomic conditions during childhood[12].

A. Anthropometry and the long-lasting effects of past history

There is a vast literature on the relevance of physical anthropometry for the study of health status of individuals (Eveleth and Tanner, 1976). However, the full relevance of anthropometric characteristics for the historical study of mortality and health and of the causative against of mortality and health changes has to be credited to a handful of researchers (Barker, 1998; Costa, 2002; Floud et al., 1990; Fogel, 1994; Gunnel et al., 1998; Kim, 1993; Komlos, 1989; Martorell et al., 2001; Schroeder et al., 1999; Scrimshaw, 1997; Tanner et al. 1982). The idea is in principle very simple: dimensions of adults' physique such as height, waist to hip ratio, body mass index, leg length, and the like are mirrors where, albeit imperfectly, past individual history is reflected. Although the image reflected by these measures is not always accurate, the measures have

[12] PREHCO administered a very extensive battery of questions on early childhood health, illnesses experienced as well as indicators of socioeconomic conditions during childhood.

surprisingly high discriminating power. A history marred by poor diet, long periods of malnutrition, repeated insults in the form of infectious illnesses leave indelible imprints in the organism. Entire physiological subsystems (respiratory, digestive, circulation) and structures (skeletal mass, bone infrastructure and proportions) come under assault and develop shortcomings, impairments and deficiencies that may sometimes be reflected in measurable physical characteristics that persist through adult ages. Birth weight reflects very early nutrition and development (Barker, 1998) and influences later developmental outcomes (Hack et al., 2002). So does supine length of the child (Eveleth and Tanner, 1976. Height, on the other hand, is a more encompassing summary measure of nutritional status (Fogel, 1994). So are knee height (length) and leg length (Gunnell et al., 1998; Tanner et al., 1982. Although the connections invoked before lead to expected relations between such anthropometric measures and health status **in general** (Costa, 2002; Fogel, 1994; Kim, 1993), there are conjectures suggesting the strong impact on one or a handful at best of well defined morbid conditions. The literature in the area and the evidence available has focused mainly on heart and circulatory diseases, congestive pulmonary illnesses and metabolic malfunctioning, particularly diabetes (Barker, 1998; Hales and Barker, 1992; Hales et al., 1991; Lithell et al., 1996). In our empirical analyses we will only focus on heart disease and diabetes.

A.1. Knee height

Body weight is a measure of current conditions while height (when it is unaffected by skeletal compression) reflects a number of conditions present during the growth period, anywhere between birth and age 20. Knee height, on the other hand, is not only a good predictor of current height in populations whose skeletal mass is compressed by age-related processes (Chumlea et al., 1998;Palloni and Guend, 2004) but it, as well as leg length, is a marker of early malnutrition. If an individual experiences growth faltering during certain periods in early childhood and adolescence, he may be able to make up for the deficits later on, but catch ‘up growth’ is more likely to occur in the trunk skeletal mass than in the leg long bones (Eveleth and Tanner, 1976). Thus, disproportionately short knee (leg) height can be a marker of early stunting.

A.2. Waist-to-Hip Ratio

Much like BMI, waist-to-hip ratio (WHR) is a powerful risk factor for a host of metabolic disorders. But the exact mechanism of influence is somewhat obscure. On the one hand, evidence from poor populations suggests that WHR is affected by early malnutrition (Martorell and Schroeder, 2001; Schroeder et al., 1999) and that its association with current metabolic disorders is a result of a mechanism linking poor early nutrition with physiological and glandular dysfunction early in the life on the individual. Thus, one would expect that WHR is associated with diabetes, for example, **even after controlling for BMI**[13]. On the other hand, however, WHR is a measure of current adiposity, is highly associated with BMI, and could also reflect hormonal and metabolic disorders produced, for example, by sustained stress (Adler et al., 2000; Ostrove et al., 2001).

This mechanism does not implicate early malnutrition.

A.3. Height, weight and BMI

Throughout we control for BMI as an important risk factor for diabetes and heart disease. Although we are also interested in exploring the effects that height and weigh each have separately and combined on health status (Costa, 2002; Fogel, 2003; Kim 1993) we pursue this elsewhere.

B. Direct assessment of past conditions

The potential relations between early childhood conditions and adult health go beyond those that can be indirectly detected via examination of anthropometric markers (Elo and Preston, 1992; Fogel, 2003). As a consequence, an alternative route to show the existence of such relations is to measure directly the degree of association between indicators of early health status and exposure to social and economic conditions that promote ill health and poor early development (e.g. poverty), on the one hand, and adult health status or propensity to develop particular diseases, on the other (Ben-Shlomo and Smith, 1991; Elo, 1998; Lundberg, 1986; Lundberg, 1991; Power et al., 1998; Rahkonen et al., 1997; Warner and Hayward 2002). The problem with this approach is that except for very rare cohort studies, indicators of early conditions can only be retrieved

[13] Note that in the SABE data there is evidence demonstrating this connection between early nutrition and WHR. In fact, results not shown here indicate that in SABE countries being in the lowest quintile of knee height strongly affects the odds of being in the upper quintile of WHR. Indeed the effects on the log odds of being in the upper quintile of WHR is about .32 (p<.000) and is highly significant. This means that the ratio of the odds of being in the upper quintile of WHR for a person in the lowest quintile of knee heights is of the order of 1.4. In contrast, neither the retrospective measure of health status nor the one on childhood socioeconomic status are related to WHR.

retrospectively. These measures are not always reliable and may be systematically biased. In what follows we show some relations gleaned from information retrieved in the PREHCO study using two sets of measures: (a) general and specific indicators of socioeconomic status during early childhood and (b) general and specific indicators of health status during early childhood and adolescence.

B.1. Early health status

We use information regarding illnesses experienced by the individual as well as an overall evaluation of their health status during the period when they were aged 5 to 15 years ("would you say that your health was excellent, good, fair, or poor"; "did you ever miss school for longer than a month due to illness?"). For convenience we group illnesses in two classes: group I includes typhoid, hepatitis, TB, rheumatic fever and polio; group II includes malaria, dengue, smallpox, pneumonia, asthma and bronchitis.

B.2. Early socioeconomic conditions

In the analyses that follows we select a few items reflecting socioeconomic conditions during childhood. One variable is constructed from an overall evaluation of retrospective experience during the period between the respondent's 5^{th} and 15^{th} birthday. A second reflects whether the individual left school to go to work and the third indicates whether the mother worked for pay regularly.

C. Findings for diabetes

We argued before that diabetes is one of the key chronic conditions whose prevalence is salient among elderly adults in Puerto Rico. On the other hand, diabetes is one of the diseases conjectured to be highly responsive to early childhood conditions (Barker, 1998). Is there any evidence in our data that current diabetes status is indeed related to early childhood conditions and development?

A straightforward way to identify the direction and magnitude of effects is to estimate the relation between indicators of early health status and the probability of self reporting diabetes. We first focus on the two anthropometric measures identified above, and then on the role of socioeconomic conditions. We estimate simple logistic models for the probability of self-reporting diabetes as a function of a number of control variables (age, gender, and education). We also include a dummy for obesity (BMI>=30) to control for the effects of the most important risk factors associated with **current** nutritional status. We then successively introduce knee height and WHR as dummies defined, respectively, as 1 when the individual scores in the first quartile of the population knee height distribution and on the upper quartile of the WHR distribution. Since the effects of these variables will be net of BMI, they cannot be interpreted as a result of current status but only of past conditions reflected in either measure. The main results are displayed in the first panel of Table 6. The estimates obtained are consistent with the conjecture: both knee height and WTR, but more the latter than the former, exert powerful effects. The estimates are statistically significant and properly signed. Note that the odds of diabetes for somebody in the lowest quartile of knee height is 1.33 as high as for those with longer a knee height. The effects of WHR are even larger: the odds ratios are 1.76 as high for those in the upper quartile of the WHR distribution. By definition, the effects concern a minority of the population (25 percent). Thus the proportionate attributable risk cannot be too large. Yet, they are far from trivial. If the values associated with the cutting points for the distributions of WHR and knee heights do in fact make a difference, “eliminating” short knee height (that is, eliminating knee heights below the cutting point) could reduce diabetes prevalence among females in the group 60-69 by about seven to ten percent (from .26 to between .23 and .24). Eliminating WHR above the cutting point would reduce diabetes in the same group anywhere between thirteen and seventeen percent (from .26 to between .20 and .22). These are not staggering amounts, but would probably suffice to remove the distinction of Puerto Rico as the country where elderly experience the highest prevalence of self reported diabetes (see above).

Do illnesses in early childhood make any difference? Table 6 displays the estimated effects of having experienced one or the other group of illnesses (see above) as well as those associated with a general indicator of health in early childhood. None of them seems to matter much for self reported diabetes.

D. Findings for heart disease

Unlike diabetes self reported heart disease is not associated with knee height or WHR; however, as expected, it is strongly associated with BMI. But perhaps the most interesting feature of heart disease is its sensitivity to the experience of diseases in early childhood and to some of the indicators of socioeconomic conditions. First, individuals who admitted to have experienced bad health are also more likely to self-report heart disease (the odds of heart diseases are 1.71 as high as among those who characterizes their early health as good). Second, having experienced at least one disease in group I se elevates the odd of heart disease by a substantial margin to about 1.6 relative to those who do not. Since we suspected that this association could be due to the influence of a single infectious disease, rheumatic fever, we introduced a separate dummy variable indicating experience with rheumatic fever and with any of the other diseases. The results are as expected: the association between to heart disease is completely shifted to the experience of rheumatic fever.

[Table 6 about here]

In summary, the estimation exercise performed on PREHCO data suggests two different conclusions. The first is that diabetes, a metabolic disorder with multiple suspected causative factors, is indeed associated with conditions reflecting early malnutrition. It does not appear to be associated with other indicators of early child health status nor with markers of poor socioeconomic conditions early in life. Our conjecture is that a subset of individuals counted among the ranks of the elderly experience diabetes in part as a result of the fact that they were able to survive despite having experienced possibly serious deprivations that led to periods of malnutrition. We would not have encountered them had their survival chances not been enhanced by the large scale deployment of medical technology during the beginning phases of the mortality decline.

The second conclusion is that the prevalence of heart diseases is closely associated with early experience of some diseases, but particularly with rheumatic fever. This is a well known association, one that can only be observed because those who experienced rheumatic disease are able to survive to old age. In addition, heart disease is more responsive to self reported socioeconomic conditions than diabetes is. This is inline with findings of the same type uncovered in other countries and cultures but the exact mechanisms are not yet identified.

VIII. Summary and Conclusions

Admittedly, our tour of PREHCO data has met with only limited success. We started out with a conjecture invoking the origin of the growth of elderly as well as the linkage between early childhood conditions and adult health status. We set out to find in observables the mark we would expect if three corollaries derived from the conjecture did indeed apply. The first corollary was confirmed only partially as Puerto Rican elderly did indeed manifest relatively worst health patterns than individuals in HRS in the US and ranked somewhat in the middle of the range established by other Latin American countries. This despite the fact that standards of living in Puerto Rico are superior when compared to that of other countries in the region. Worthy of note were the very high levels of self-reported diabetes and obesity. Upon inspection of pertinent data sets we found that these levels are reproduced among Hispanics living in the US but nowhere else.

The second corollary indicated that we should find marked gradients of health outcomes in those countries most affected by the growth of elderly population contributed by the mortality decline. We do find very sharp levels of inequality everywhere and in all outcomes, regardless of whether we use income or education, but nowhere are these as high as those encountered in the HRS in the US. Puerto Rico does not stand out as a cradle of large inequalities: the gradients there are more or less the same as everywhere else in the region.

Finally, we do find some support for the third corollary as diabetes appears associated with markers of early malnutrition and heart disease is associated with early deprivations and selected early childhood conditions. But although this analysis is more successful than the others, it is certainly a blunt tool for a number of reasons. First, focusing on current diabetes status constrains the universe of study to those who were able to survive with the disease. It is likely that those in worst health had a lower chance of surviving and of being interviewed. Second, although self reported diabetes is generally quite accurate (Palloni et al., 2003; Goldman et al., 2002), even mild measurement errors can lead to powerful attenuation of estimated effects. Third, indicators of early child conditions--anthropometry and retrospective questions--are retrieved in a population-based study, carried via person-to-person interview, not a clinical setting. As a consequence, the anthropometry may be subject to random errors with the consequent distorting effects on estimates of association between variables.

While formulation of the conjecture may provide ample room for testing a number of related hypotheses and thus be a guiding torch to uncover related regularities, a full-fledged test of its accuracy may well be impossible in the absence of cross national information with exquisitely detailed information regarding current health status and mortality, access to and use of health services, and, above all, past experiences of the individuals.

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Table 1: PREHCO basic demographic (weighted) data

	Male		Female	
	n	%	n	%
Age group				
60-64	74,751	28.6	87,799	26.7
65-74	110,464	42.3	135,149	41.2
75 +	76,031	29.1	105,304	32.1
Marital status				
Married	186,331	71.4	133,051	40.5
Widowed	29,200	11.2	124,079	37.8
Divorced	19,953	7.6	40,389	12.3
Separated	9,564	3.7	11,575	3.5
Never Married	16,018	6.1	19,158	5.8
Living arrangements				
Living alone	45,452	17.4	89,492	27.3
Living with others	215,614	82.6	238,760	72.7
Education				
Six years or less	103,193	40.2	151,900	47.2
More than six years	153,292	59.8	169,767	52.8
Race				
White Hispanic	110,470	49.5	133,267	47.3
Black / mulatto / trigueño	91,075	40.8	131,419	46.6
Other	21,806	9.8	17,280	6.1

Table 2: SABE - Basic Sample Information

Condition/ Variable	Overall (n=10,902)	Argentina (n=1043)	Barbados (n=1808)	Brazil (n=2143)	Chile (n=1306)	Cuba (n=1905)	Mexico (n=1247)	Uruguay (n=1450)
Response Rate		0.60	0.85	0.85	0.84	0.95	0.85	0.66
Age	72 (8)	71 (7)	72 (8)	73 (8)	72 (8)	72 (9)	70 (8)	71 (7)
60-64	23%	23%	19%	20%	22%	25%	31%	22%
65-69	23%	24%	23%	18%	25%	21%	25%	25%
70-74	19%	24%	21%	16%	19%	18%	18%	23%
75-79	17%	15%	17%	22%	16%	13%	13%	17%
80-84	11%	8%	11%	14%	10%	11%	8%	9%
85+	8%	5%	9%	10%	8%	11%	6%	5%
Gender								
Females	62%	63%	60%	59%	66%	63%	59%	63%
Education								
Primary	71%	71%	77%	85%	68%	57%	74%	65%
Secondary	20%	23%	18%	5%	24%	37%	11%	21%
Higher	9%	6%	5%	10%	9%	7%	15%	14%
Race								
White	55%	---	5%	71%	43%	63%	---	90%
Black	34%	---	93%	16%	1%	36%	---	4%
Mestizo	6%	---	0.84%	8%	30%		---	6%
Other	4%	---	1%	5%	26%	0.58%	---	0.07%
Marital Status								
Never	7%	6%	18%	5%	7%	3%	4%	4%
M	46%	43%	45%	52%	44%	37%	54%	49%
S	9%	9%	9%	6%	13%	13%	9%	6%
W	34%	42%	24%	35%	36%	35%	32%	37%
D	4%	0.96%	5%	1%	0.39%	11%	1%	5%

Source: SABE data, respondents ages 60 and above. Numbers in parentheses are standard deviations where appropriate. Numbers rounded to nearest whole number. For race: the category Black includes blacks and mulattos and the category Other includes indigenous, Asian and all other. Information on race is not available for Mexico or Argentina. Marital Status: M=married or in a union, S=separated, W=widowed, D=divorced

Table 3: SABE - Health and Other Attributes of Sample

Condition/ Variable	Overall (n=10,902)	Argentina (n=1043)	Barbados (n=1808)	Brazil (n=2143)	Chile (n=1306)	Cuba (n=1905)	Mexico (n=1247)	Uruguay (n=1450)
Diabetes	17%	13%	22%	18%	14%	15%	22%	13%
Medicine	68%	64%	78%	64%	70%	60%	82%	52%
Insulin	12%	10%	15%	14%	6%	15%	9%	11%
Cancer	4%	5%	4%	4%	5%	3%	2%	6%
Respiratory	10%	8%	4%	13%	13%	13%	10%	9%
Heart	21%	20%	12%	21%	34%	24%	10%	23%
Stroke	7%	5%	6%	8%	7%	10%	5%	4%
Arthritis	42%	53%	47%	33%	32%	58%	25%	47%
Obesity	24%	------	24%	20%	30%	14%	30%	34%
Poor health	11%	5%	5%	9%	21%	13%	20%	7%
ADL	20%	19%	14%	24%	26%	21%	19%	17%
IADL	29%	29%	23%	40%	32%	28%	29%	17%
Height (cm)	158 (10)	------	163 (10)	157 (9)	155 (10)	158(10)	154 (9)	160 (9)
Knee height (cm)	50 (5)	------	53 (5)	50 (3)	48 (3.3)	50 (5)	49 (4)	48 (6)
Weight (kg)	67 (16)	------	72 (20)	64 (13)	67 (14)	61 (14)	66 (12)	72 (15)
BMI (w/h^2)	27 (6)	------	27 (8)	26 (5)	28 (5)	25 (5)	28 (5)	28 (7)

Source: SABE data. Numbers rounded to nearest whole number. Poor health 1=Poor, 0=All other. ADL=at least 1 ADL. IADL=at least 1 IADL. No height and weight measurements were taken in Argentina.

Table 4: Summary of "Population Effects" on Health Outcomes[(a)]

Effects of Population	Reporting Bad Health		Reporting at least 1 ADL		Reporting at least 1 IADL		Diabetes (self-report)		Mean Number of Chronic Conditions	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Argentina	-.19	(-1.00)	.17	(1.34)	.64	(4.84)	.063	(.45)	.01	(.22)
Barbados	-.05	(-.29)	-.30	(-2.37)	.37	(7.77)	.76	(5.41)	-.07	(-1.6)
Brazil	.56	(-3.17)	.37	(2.92)	1.14	(8.65)	.51	(3.68)	0.03	(-.75)
Chile	1.44	(8.20)	.51	(4.02)	.78	(5.90)	.25	(1.74)	.00	(.09)
Cuba	.79	(4.49)	.20	(1.60)	.57	(4.30)	.04	(.27)	.19	(4.19)
Mexico	1.29	(7.30)	.40	(3.15)	.86	(6.49)	.80	(5.75)	-.24	(-5.42)
Uruguay	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
HRS	.45	(2.57)	.32	(2.47)	-.51	(-3.83)	.46	(3.29)	.41	(9.20)
PREHCO	1.05	(5.90)	-.35	(-2.74)	.64	(4.85)	1.10	(7.87)	.17	(3.74)

.

(a) Estimates of effects associated with each subpopulation (data set) on the logit of the proportion experiencing a given outcome (except for number of chronic conditions). The models use as unit of analysis subpopulations defined by the intersection of age groups (three), gender (two) and subpopulations (9). The dependent variable is the logit of the proportion self-reporting the given health outcome in a given unit of analysis.

(b) Uruguay is the residual category for the dummies for data sets (subpopulations)

(c) Regression of self-reported mean number of chronic conditions using OLS. Equivalent results are obtained using instead the proportion reporting at least one chronic condition.

Table 5: Estimates of Effects of Education and Income on the Log Odds of Selected Outcomes[(a)]

	Reporting Bad Health		Reporting at least 1 ADL		Reporting at least 1 IADL		Diabetes (self-report)	
	Estimate	**t-value**	**Estimate**	**t-value**	**Estimate**	**t-value**	**Estimate**	**t-value**
Model 1[(b)]								
Income (lst Qunitile)	.25	3.26	.15	2.48	.35	6.44	.20	2.84
Interaction Income x PREHCO	.083	.63	-0.06	-.43	-.13	-1.20	.090	.73
Model 2[(c)]								
Education (less than 6 years)	.52	6.3	.54	8.4	.55	9.7	.28	4.1
Interaction Education x PREHCO	.02	.19	-.26	2.25	-.03	-.03	-.10	-1.1

(a) Logistic models for individual probabilities of experiencing a health outcome. Pooled samples; all models include controls for gender, age, and data set (country).

(b) Model 1 includes a dummy variable for 1st quintile of country-specific income distribution. It is thus a proxy for poverty.

(c) Model 2 includes a dummy variable for primary level of education or less.

Table 6: Estimates of effects of indicators of early nutritional status, early childhood health and early socioeconomic conditions on diabetes and heart disease [a] [b]

	Panel 1: Diabetes	
	Model 1	Model 2
1^{st} Quart knee height	.204(.09)	-
Last Quart WHR	-	.511(.09)
BMI>=30	.317(.08)	.281(.09)
Early Childhood Bad Health [c]	.185(.10)	.180(.10)
Poor during early childhood [d]	-.042(.09)	-.027(.09)
n	3415	3417
Likelihood Ratio	-1975	-1961
LR Chi-square(11)	42.03	68.98

(a) All models control for age group, gender and education. Results are not weighted.
(b) There were some missing cases overall in the sample for anthropometric measurements. In addition, within models there were missing data among variables and therefore the sample sizes will not always be identical across models. Missing values were not imputed.
(c) Indicator derived from a general 5-point question appraising health during childhood (bad health=poor or fair health).
(d) Indicator derived from a general 3-pont question appraising socioeconomic conditions during early childhood (poor=poor economic conditions).

Table 6 (cont): Estimates of effects of indicators of early nutritional status, early childhood health and early socioeconomic conditions on diabetes and heart disease [(a)] [(b)]

Panel 2: Heart Disease

	Model 1	Model 2	Model 3	Model 4	Model 5
1st Quart knee height	-.013(.12)	-	-.077(.12)	-	-
Last Quart WHR	-	-.035(.11)	-	-.062(.11)	-.068(.11)
BMI>=30	.355(.10)	.355(.10)	.330(.10)	.334(.10)	.337(.10)
Early Childhood Bad Health	.491(.11)	.492(.11)	-	-	-
Poor during early childhood (b)	.403(.10)	.405(.10)	.424(.10)	.428(.10)	.423(.10)
Disease Group I [(e)]	-	-	.644(.16)	.631(.16)	.480(.20)
Rheumatic Fever	-	-	-	-	.601(.27)
n	3245	3247	3199	3201	3197
Likelihood Ratio	-1474	-1475	-1433	-1444	-1442
LR Chi-square	83.84 (df=10)	83.11 (df=10)	75.56 (df=10)	74.27 (df=10)	72.89 (df=11)

(a) All models control for age group, gender and education. Results are not weighted.
(b) There were some missing cases overall in the sample in anthropometric measurements. In addition, within models there were missing data among variables and therefore sample sizes will not be identical across models. Missing values were not imputed.
(c) Indicator derived from a general 5-point question appraising health during childhood (bad health=poor or fair health).
(d) Indicator derived from a general 3-pont question appraising socioeconomic conditions during early childhood (poor =poor economic conditions).
(e) In Models 3-4, Disease Group I included the following diseases: typhoid, hepatitis, TB, rheumatic fever and polio. In Model 5, Disease Group I did NOT include rheumatic fever.

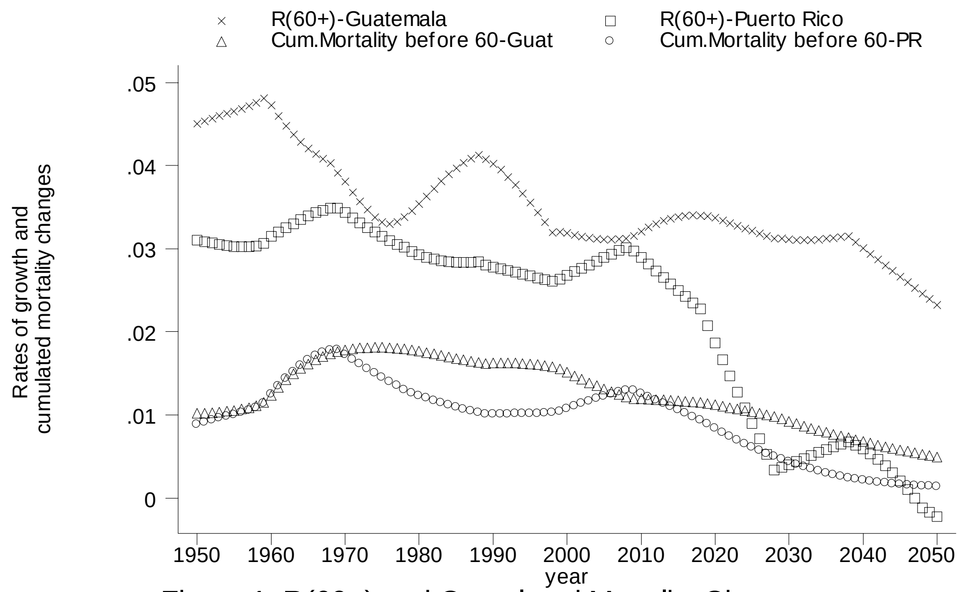


Figure 1: R(60+) and Cumulated Mortality Changes

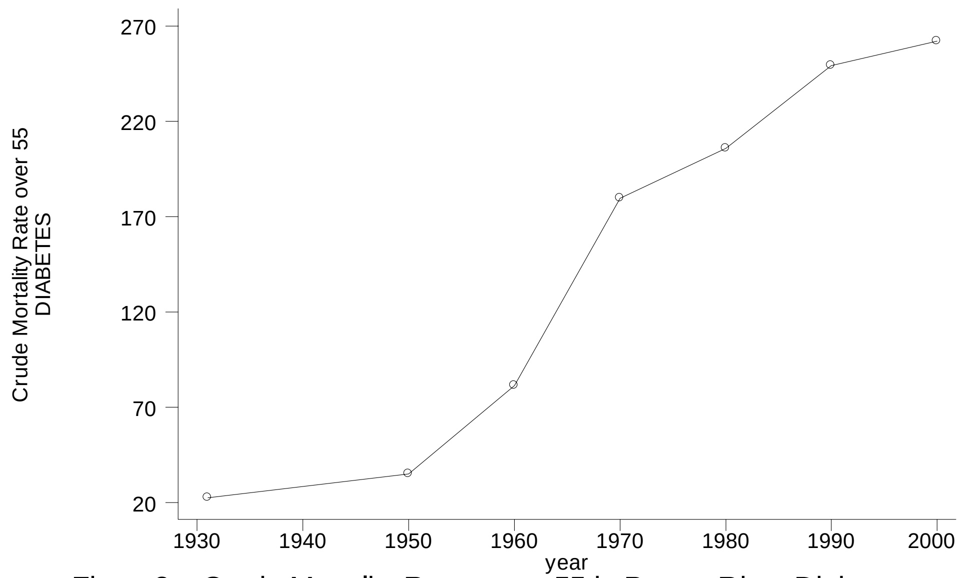


Figure2a: Crude Mortality Rates over 55 in Puerto Rico: Diabetes

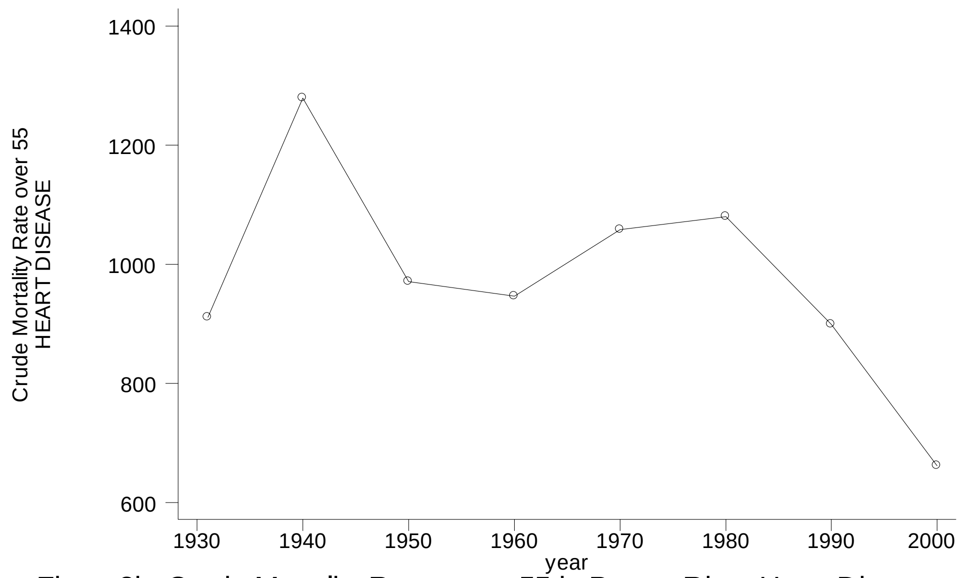


Figure2b: Crude Mortality Rates over 55 in Puerto Rico: Heart Disease

Figure 3a: Proportion Bad Health by Age/Sex

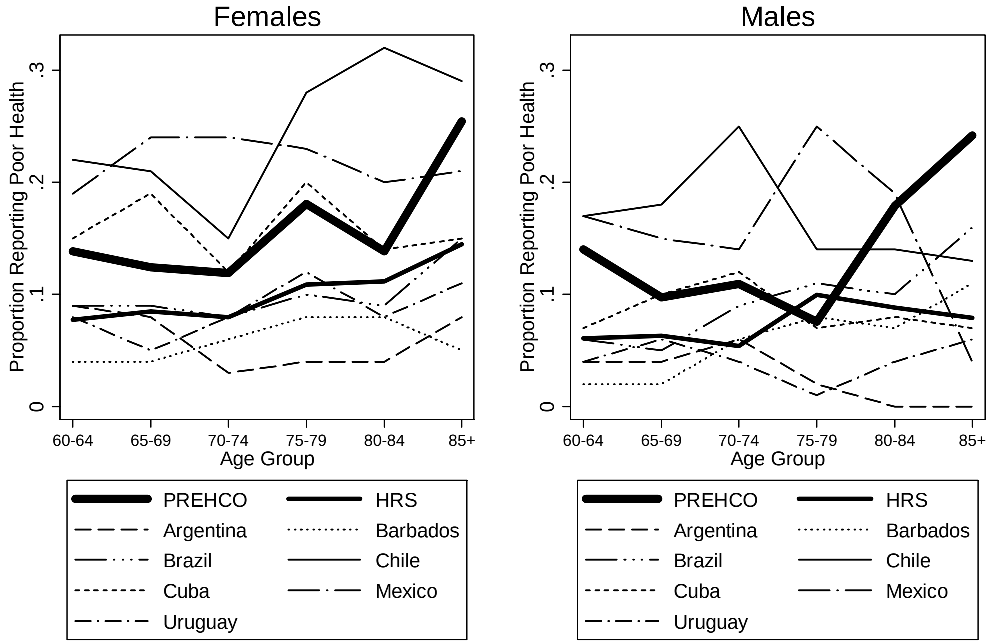


Figure 3b: Proportion with at Least One ADL by Age/Sex

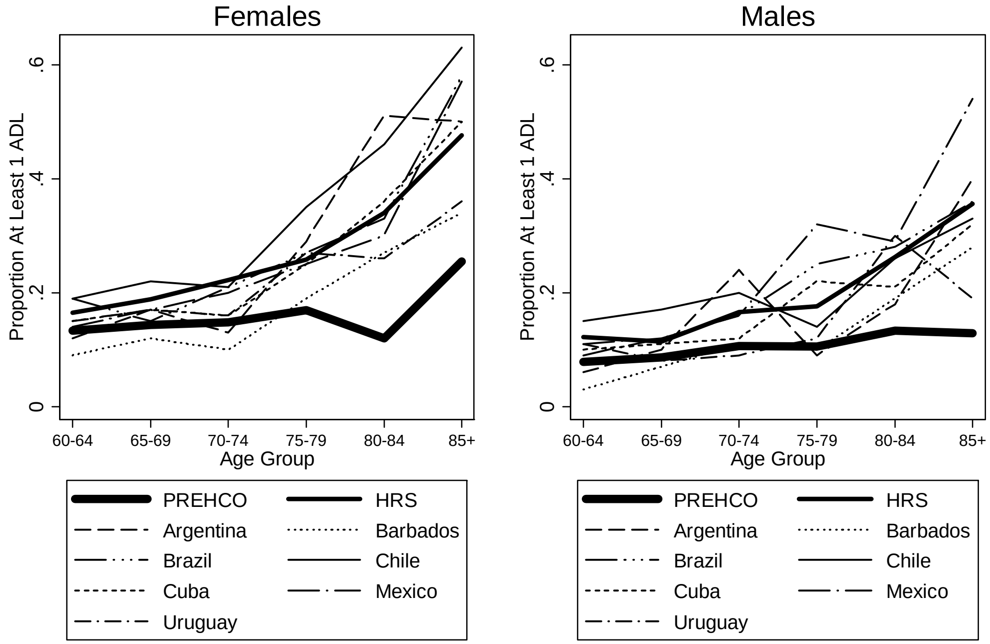


Figure 3c: Proportion with at Least One IADL by Age/Sex

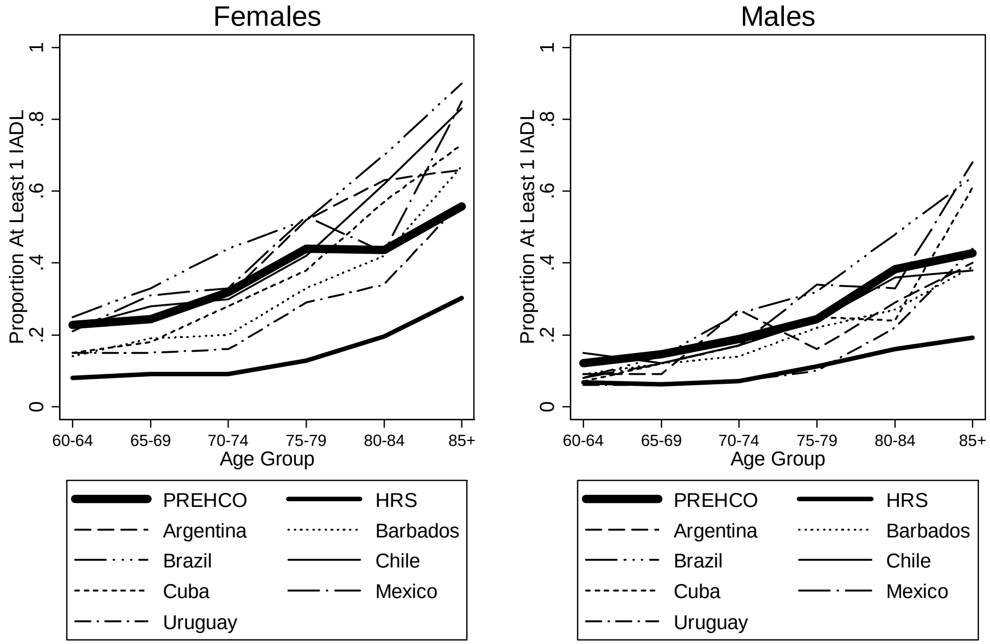


Figure 3d: Mean Number of Chronic Conditions by Age/Sex

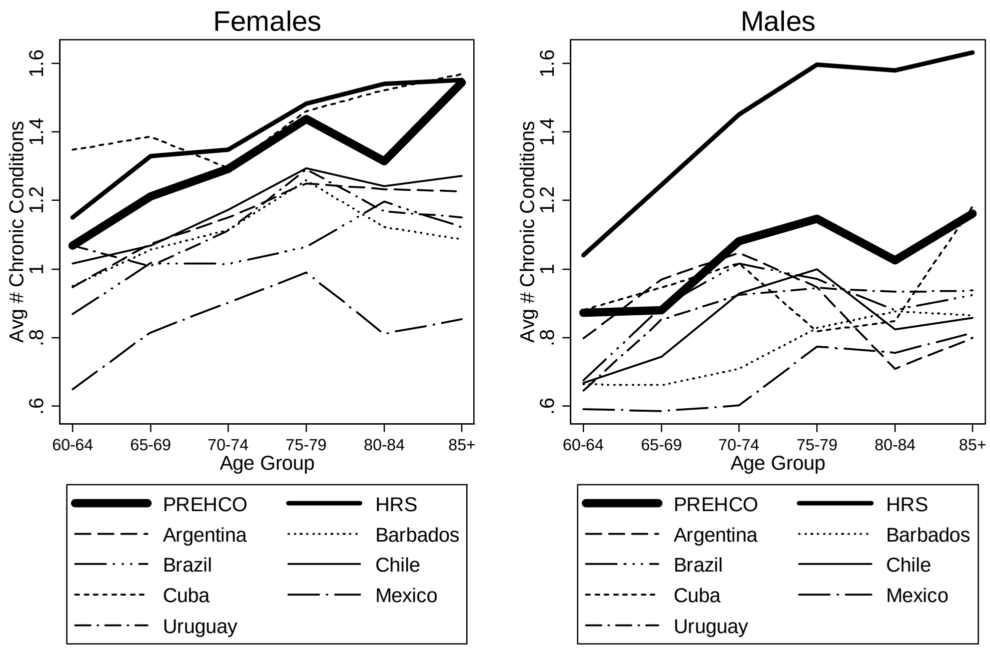


Figure 4a: Proportion Self-Reporting Diabetes by Age/Sex

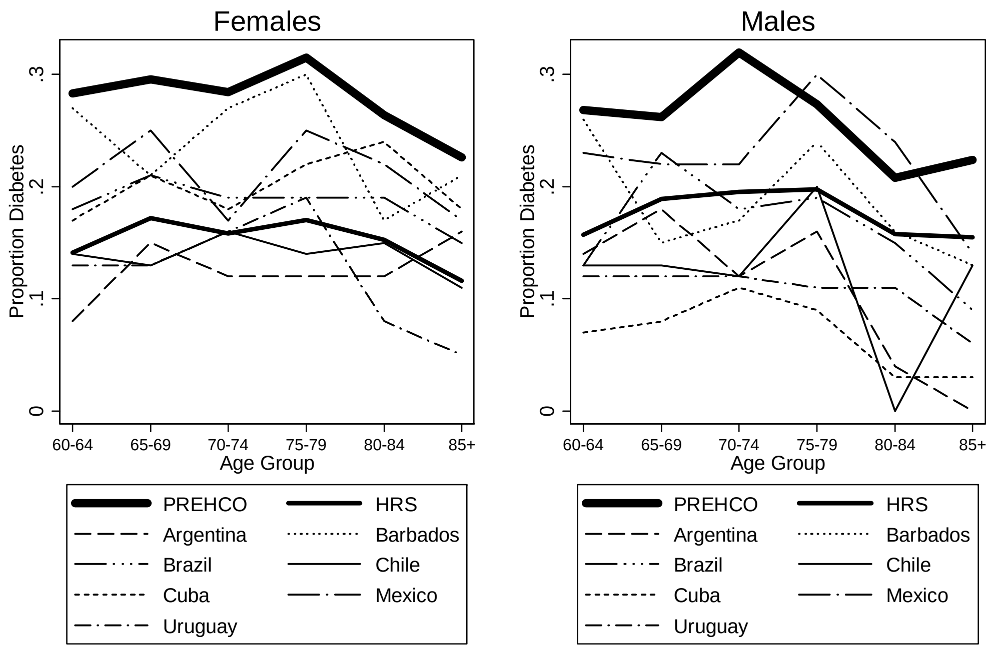


Figure 4b: Proportion Obese by Age/Sex

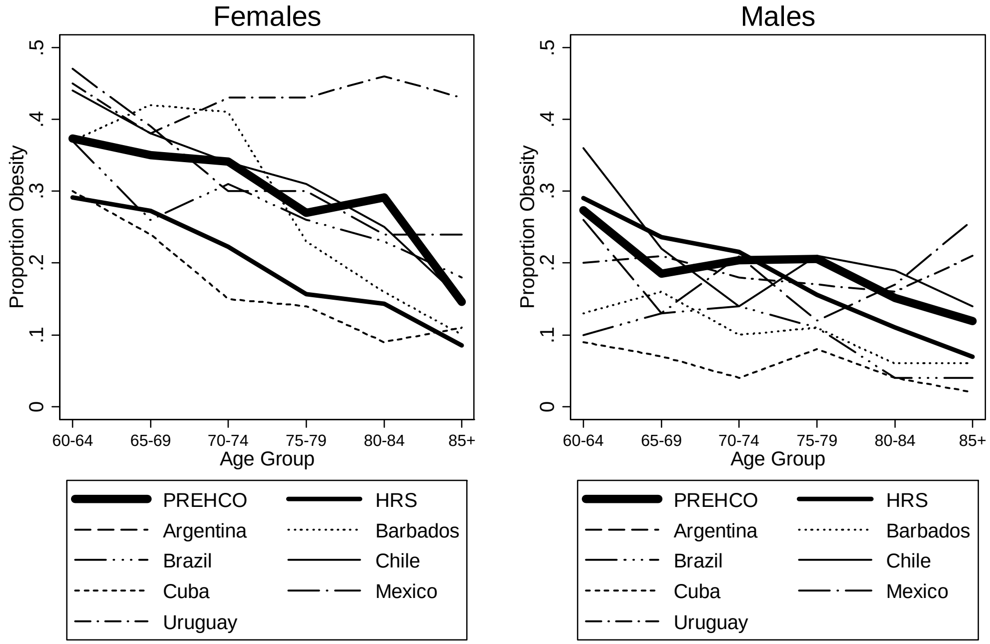
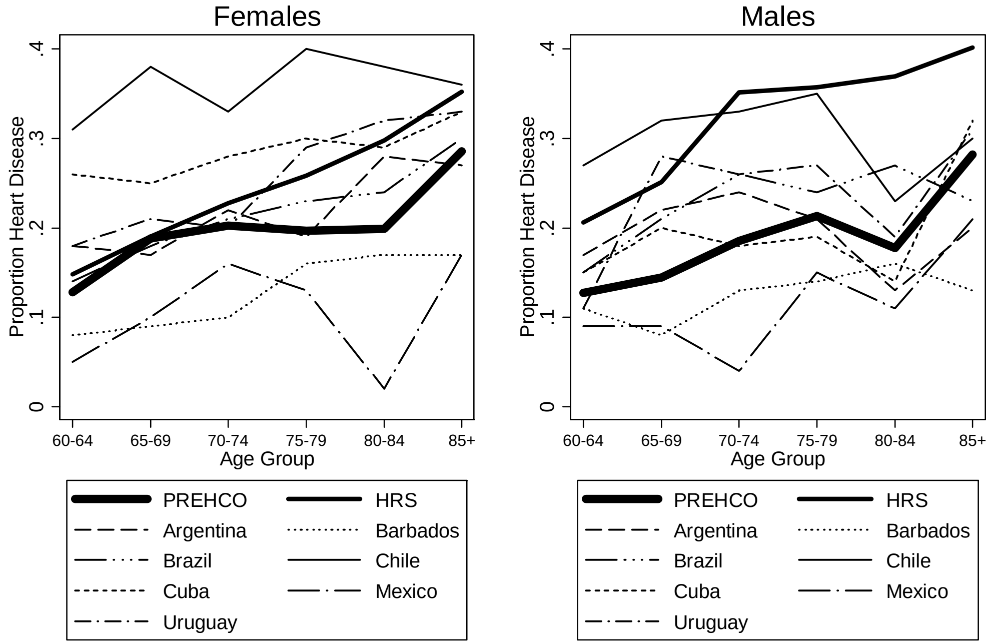


Figure 4c: Proportion Self-Reporting Heart Disease by Age/Sex



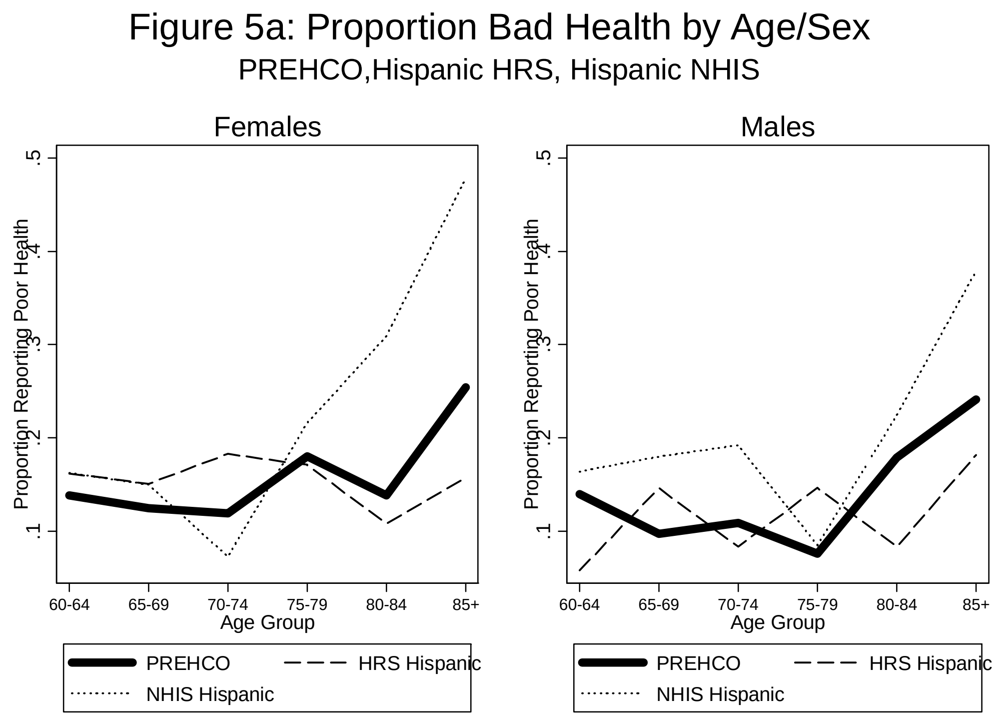


Figure 5a: Proportion Bad Health by Age/Sex
PREHCO,Hispanic HRS, Hispanic NHIS
Females
Males
Proportion Reporting Poor Health
.1
.2
.3
.4
.5
60-64
65-69
70-74
75-79
80-84
85+
Age Group
PREHCO
HRS Hispanic
NHIS Hispanic

Figure 5b: Proportion with at Least One ADL by Age/Sex

PREHCO,Hispanic HRS, Hispanic NHIS

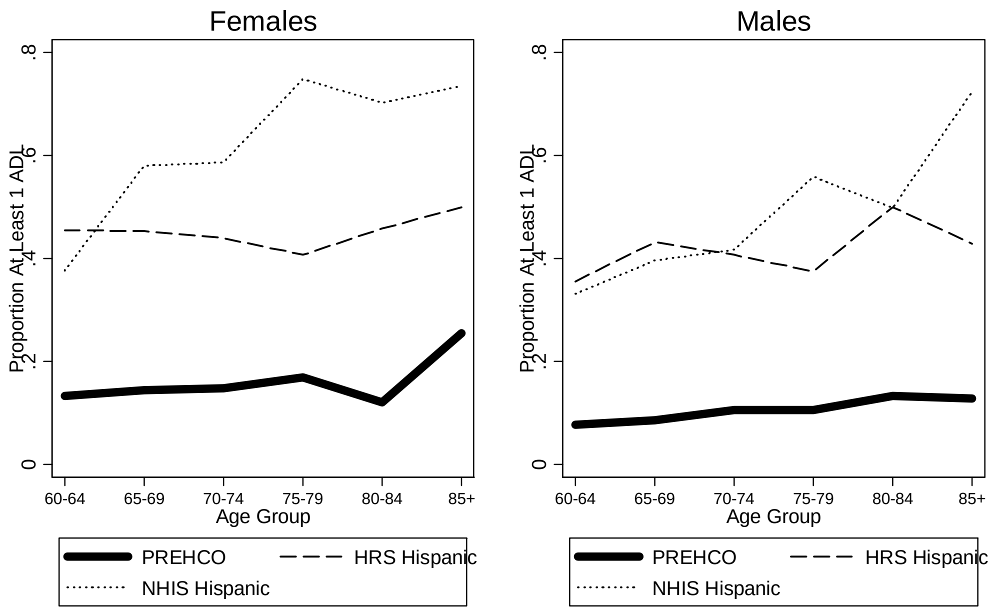


Figure 5c: Proportion with at least One IADL by Age/Sex

PREHCO,Hispanic HRS, Hispanic NHIS

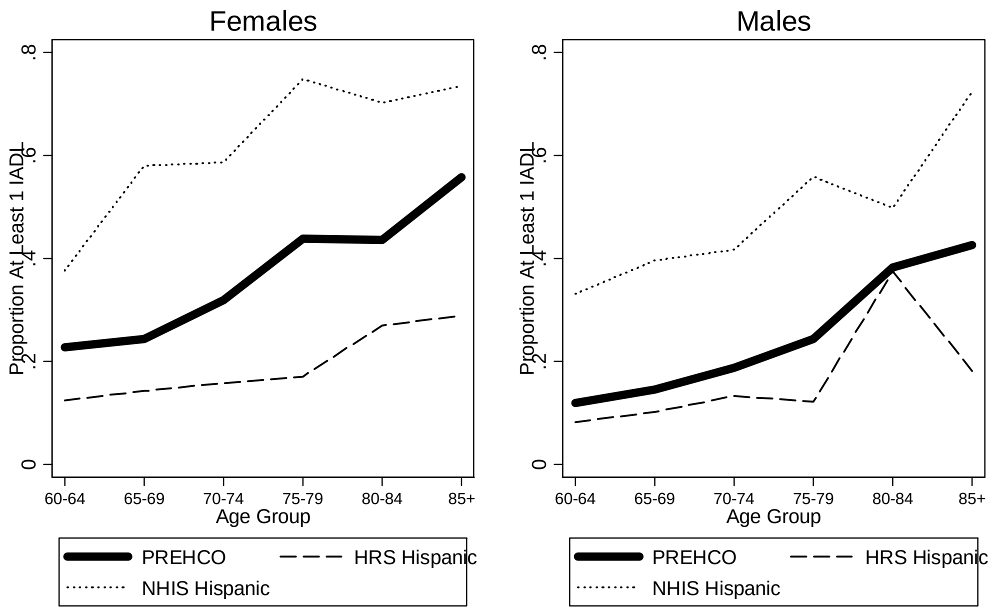


Figure 5d: Mean Number of Chronic Conditions by Age/Sex

PRECHO,Hispanic HRS, Hispanic NHIS

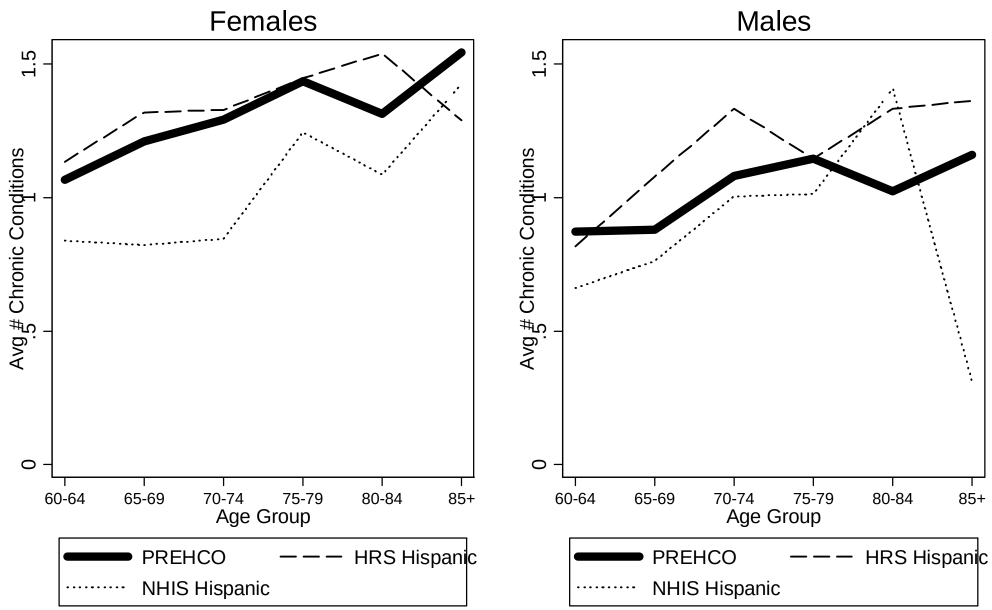


Figure 5e: Proportion Self-Reporting Diabetes by Age/Sex

PREHCO,Hispanic HRS, Hispanic NHIS

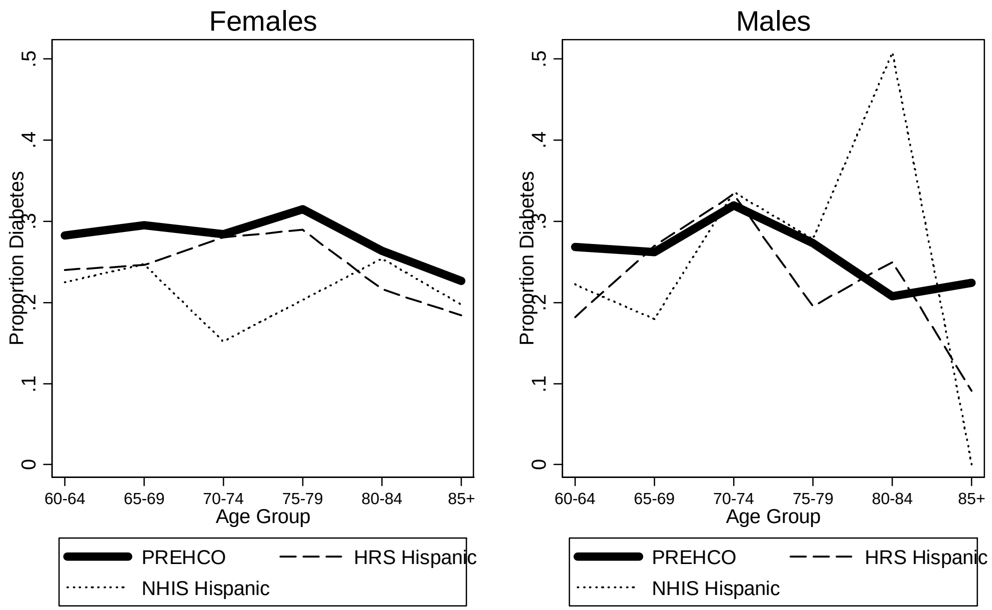


Figure 5f: Proportion Obese by Age/Sex

PREHCO,Hispanic HRS, Hispanic NHIS

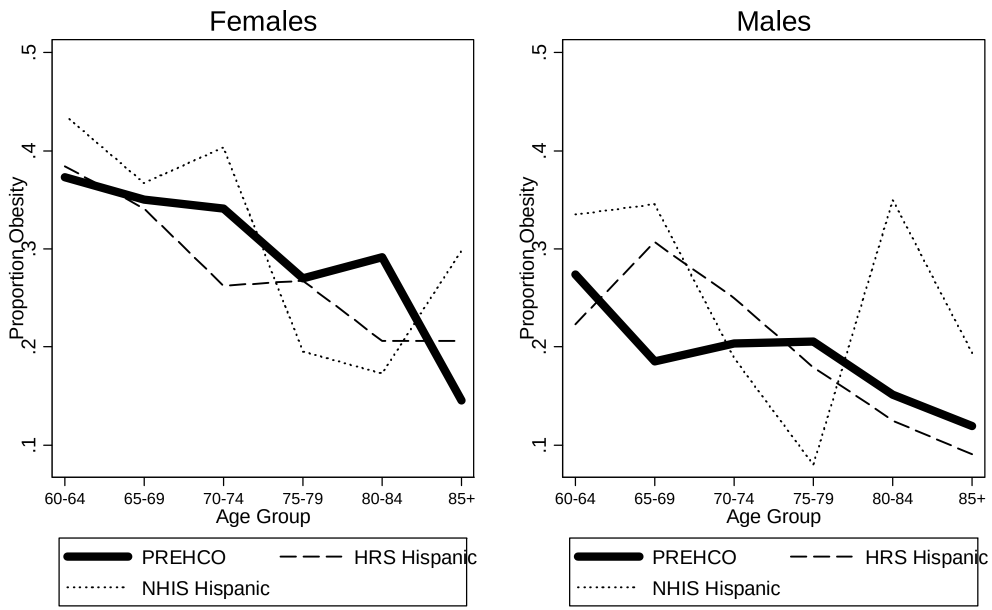


Figure 5g: Proportion Self-Reporting Heart Disease by Age/Sex

PREHCO,Hispanic HRS, Hispanic NHIS

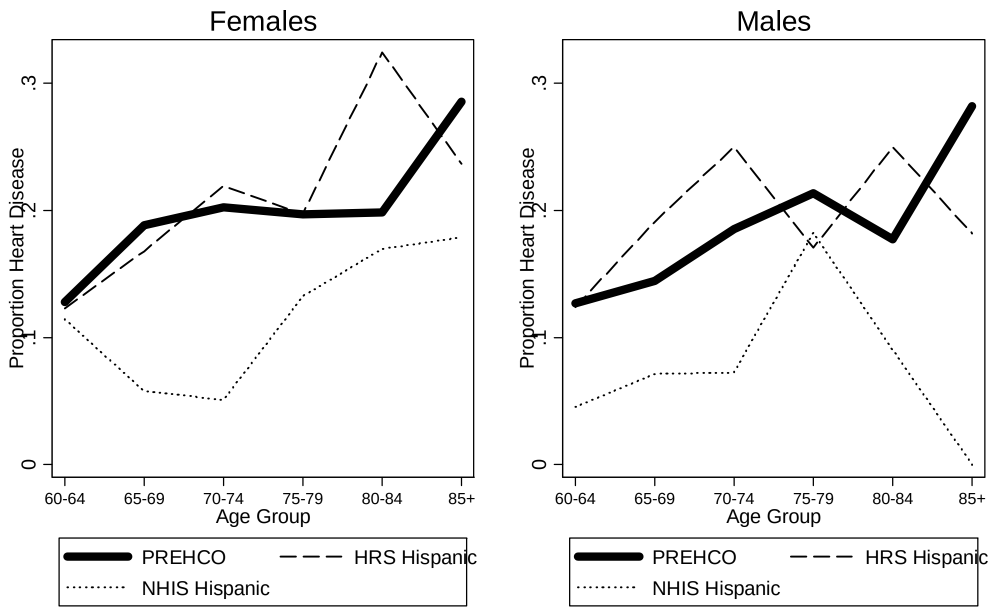


Figure 6: Association Between Income In Quintiles and Health Outcomes