The Impact of Education and Health Heterogeneity on Generational Support Ratios in Mexico

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Abstract

Policymakers around the world are concerned about the socioeconomic consequences of population aging in terms of who will bear the costs of older generations. Their policies often rely on estimations of support ratios based solely on the age structure of the population. In this paper, we estimate generational support ratios (GSRs) to examine the dependency of older generations to new generations, taking into account health heterogeneity in the older population and education heterogeneity in the offspring generation that will provide for them.

Moreover, since educational expansion have occurred in tandem with improvements in health, we explore what would be the effect of a public policy that changes the education of a targeted subgroup of women when they were young once these women become older. We explore how changes in women's educational distribution (i) affect women's health distribution when they become old, and (ii) affect GSRs through changes in intermediate demographic processes, such as assortative mating, fertility behavior, and intergenerational transmission of education. Finally, we conduct a series of simulations to show the contribution that each demographic process has on changes in GSRs. Our study site is Mexico, one of the most rapidly aging countries around the world.

Our results indicate that improvements in women's education lead to (i) improvements in health (ii) declines in GSRs of all offspring per elderly due to associated reductions in fertility, but this decrease is not substantial; (iii) increases in the number of college-educated offspring per unhealthy elderly due to improvements in both offspring's education and elderly health. Moreover, all the improvements observed in the health distribution of women are boosted by the

changes of demographic behaviors. Finally, our results highlight the importance of taking into account changes in demographic behaviors in the estimation of changes in support ratios, because improvements in offspring's education and in elderly health may mitigate the negative consequences associated with population aging.

Introduction

Population aging is a general trend in many regions of the world. Increases in life expectancy coupled with decreases in fertility rates have led to an increase in the proportion of elderly people. The median age of the world population is forecasted to rise from 26.7 to 38.1 years between 2000 and 2050 (Goldstein 2009). Moreover, population projections indicate that between 2050 and 2080 one third of the population will be 60+ years old (in all regions in the world with the exception of sub-Saharan Africa) (Lutz et al. 2008).

Policymakers around the world are concerned about the socioeconomic consequences of population aging in terms of who will bear the costs of older generations. Some industrialized countries have attempted to develop pronatal policies to balance the population's age structure and increase its support ratio[1] (Kalwij 2010; McDonald 2002). Some countries are debating whether it would be appropriate to increase the age of retirement assuming that the increase in life expectancy is a consequence of improvements in health (Lutz et al. 2008; Martin et al. 2010). These policies often rely on estimations of support ratios that are based solely on the age structure of the population to determine the burden for the next generation (e.g. Lee and Tuljapurkar 1997), or in projections of the elderly population that take into account their educational attainment (Batljan et al. 2009; Batljan and Thorslund 2009; Joung et al. 2000). However, support ratios need to incorporate characteristics of the elderly, as well as, characteristics of the offspring generation that will provide for them.

In this paper, we estimate generational support ratios (GSRs) to examine the burden of older generations on new generations taking into account characteristics of the elderly (i.e. educational attainment and health status when they are old), as well as, characteristics of the

[1] The support ratio is the inverse of the old-age dependency ratio.

offspring generation (i.e. educational attainment) that will provide for them. Moreover, we examine how changes in educational attainment affect GSRs, taking into account demographic behaviors such as assortative mating, differential fertility, and the intergenerational transmission of education. Finally, we conduct a series of simulations to show what is the contribution of each demographic process on changes in GSRs and on changes in the health distribution of the elderlies.

This demographic approach was first introduced by Mare and Maralani (2006) and has been adapted to analyze different social processes (e.g. Kye and Mare 2009). The current study is based on an extended version of that model developed by (Kye et al. 2012). By acknowledging the configuration of the elderly population and of the next generation, we can inform more adequately policy makers to what extent new better-educated generations are able to support new better-educated and healthier elderlies.

Generational Support Ratios

Conventional measures used in the population aging literature to estimate the burden of older generations on new generations are based on chronological age. The most popular measure is the old-age dependency ratio or the number of individuals over 65 (considered by the United Nations "the elderly") divided by the number of individuals between the ages of 15 and 65 years old (considered by the United Nations the population economically active (Goldstein 2009). Some researchers redefine the "the elderly", as the population in age groups with a remaining life expectancy of 15 years (Lutz et al. 2007). This new definition adjusts for recent improvements in health, associated with longer longevity. In several regions of the world, these improvements in health have occurred at the same time as educational expansion. The educational configuration of new generations may also be an important characteristic that should be taken into account when estimating support ratios, since better-educated offspring may be able to provide more financial resources to their elderly parents, and may also have access to useful information to care better for them. In this sense, it may also be important to define "the active" based, not only on age, but also in their educational attainment.

In our paper, we proposed the following measures measures of GSRs, to acknowledge the health configuration of the elderlies as well as the configuration of the new generation.

$$GSR_1 = \frac{\#\ \text{Offspring}}{\#\ \text{Elderly}}$$

$$GSR_2 = \frac{\#\ \text{Offspring}}{\#\ \text{Unhealthy Elderly}}$$

$$GSR_3 = \frac{\#\ \text{Offspring with education } j}{\#\ \text{Elderly}}$$

$$GSR_4 = \frac{\#\ \text{Offspring with education } j}{\#\ \text{Unhealthy Elderly}}$$

The offspring in the numerator refers to adult children born to the adults older than 60 years old[2] in the denominator. Educational heterogeneity of the offspring generation is incorporated in the measures by using as the numerator the number of offspring within certain educational category (i.e. offspring with 12 or 13+ years of education). The GSR of all offspring per elderly captures how many people in the offspring's generation is available to support an elderly in the parental generation; the ratio of all offspring with 13+ years of education per unhealthy elderly captures how many college educated people in the offspring's generation are available to support an unhealthy elderly in the parental generation; and so forth.

[2] The selection of the age that defines "the elderly" may vary depending on the context. In our case, this cut-off is based in the age of retirement in our study site, Mexico, in which the age of retirement varies from 55 to 65 years old.

Since educational attainment occurred in tandem with improvements in health, we explore what would be the effect of a public policy that changes the education of a targeted subgroup of women when they are young once these women become older. In particular, we examine how changes in women's educational distribution affect women's health distribution when they become old, and affect GSRs through changes in intermediate demographic processes, such as assortative mating, fertility behavior, and intergenerational transmission of education.

Education and Health

Traditional research based on individual level data shows a positive association between health and education. Evidence from developed countries shows that the more educated enjoy better health and survival chances in later life (e.g., Cutler and Lleras-Muney 2008; Elo and Preston 1996; Adler and Ostrove 1999). Recent studies have found significant causal effects of education on health and mortality in the United States and Scandinavian countries (e.g. Orepoulos 2007; Spasojevic 2011). Another line of research shows that better-educated people enjoy better health and survival chances than the less-educated because they are less likely to engage risky behaviors and possess more socioeconomic resources (e.g. Chandola et al. 2006; Ross and Wu 1995). Even though for developed countries there is strong evidence of the existence of a social gradient on health, for developing countries the evidence is not conclusive. Evidence from Mexico shows a reversal in the gradient using behavioral indicators such as obesity, smoking and alcohol consumption. However, using self-rated health and physical functioning measures, Mexican data shows the existence of a social gradient on health (Smith et al. 2007).

Education leads to better health outcomes not only through the improvement of own education but also from improvements in the education of all family members. Spouse's education is positively associated with individual's health (Huijts et al. 2010; Monden et al. 2003) and survival chances (Bosma et al. 1995), and offspring's education is positively associated with elderly health and survival chances because better-educated offspring provide their parents with more support than do their less-educated counterparts (e.g. Friedman and Mare 2010).

The positive association between health status and education suggests that a policy intervention focused on improving the educational attainment of one segment of the population, when they are young, may lead to improvements in their health status by the end of their life. At the population level, this type of policy is likely to increase the proportion of healthy elderlies, once this population becomes old, as well as, the total number of elderlies, since better-educated people may live healthier and longer lives. By looking only at the direct effects of education on health status, we would expect that such a policy would decrease the number of offspring per elderly. However, to fully understand the effects that an educational expansion may have on this support ratio, it is important to consider, also, the indirect effects that an educational expansion may have in GSRs through intermediate demographic processes. For example, an expansion in women's educational attainment, when they are young, may lead to the reduction in the number of children they will have, thus reducing the available offspring that will provide for them, once they become old, which may deteriorate even more GSRs.

In general, previous studies often overlook the additional impact that an educational expansion may have on GSRs, through several intermediate demographic processes that are associated with an educational expansion. Our model focuses on three demographic processes: (i) marriage behavior, (ii) fertility behavior, and (iii) intergenerational transmission of education.

The following diagram explains our model.

<Figure 1>

The model in Figure 1 indicates the following. First, improvements in women's educational attainment may lead to changes in their incentives to marry and in the characteristics of the partner they will marry. By improving women's education, some theories suggest that women's gains from marriage may be reduced by the improvement in their labor market position; hence their incentives to marry may be lessened (Becker 1973). By contrast, other theories suggest that highly educated women may have more incentives to marry because by attaining a higher education level they may become more attractive in the marriage market (Oppenheimer 1988). If incentives to get married are diminished, then the increased proportion of never-married women may deteriorate the health distribution, at the population level, because on average never-married persons show higher mortality risks and worst health outcomes than married persons (Ikeda et al. 2007; Hu et al. 1990). Furthermore, reductions in the incentives to form a union may lower women's fertility, which in turn may have an additional impact in health in later life. By contrast, if incentives to get married are increased, we may observe an improvement in the health distribution. Moreover, research on assortative mating by education suggests that improvements in educational attainment may lead to the choice of a better-educated partner (e.g. Mare 2008; Esteve and McCaa 2007). By marrying a better-educated spouse, the probability of having better health in later life may be greater (e.g. Huijts et al. 2010; Monden et al. 2003).

Second, improvements in women's and husband's education are likely to affect fertility behavior by reducing the number of children they will bear[3] (Bongaarts 2003; Jejeeboy 1995; Skirbekk 2008). However, the effect on family size on elderly health is not conclusive. On the one hand, the reduction in family size may have positive consequences on health because high parity women are more likely to present worse health outcomes (e.g Grundy and Holt 2000; Kington, Lillard, and Rogoswsk 1997; Grundy and Tomassini 2005; Engelman et al. 2010); moreover, having and raising many children may lead to economic strain, role overload, and stress, leading to worse health (Hank 2010). However, the reduction in the number of children may also have no impact in health (Spence 2008), or it may even have negative effects on health in some social contexts (Hank 2010). On the other hand, having more children may increase support for elderly parents, thus enhancing their health.

Third, improvements in women's and husband's education, as well as, changes in parity are likely to affect offspring's education. Evidence from the social stratification literature shows a positive relationship between parental education and offspring's education (e.g., Mare 1981; Shavit and Blossfeld 1993; Oreopoulos et al. 2006); hence improvements in parental education are likely to improve offspring's educational outcomes, thus enhancing elderly health (Friedman and Mare 2010; Zimmer et al. 2002).

Fourth, improvements in women's education, when they are young, may have a direct effect on women's health when they are old, as well as, indirect effects through changes in intermediate demographic processes.

Finally, this model provides a framework that allows for the analysis of how upgrading the educational attainment of a targeted subgroup in the population may affect GSRs, through

[3] The causality of this relationship still remains controversial (e.g. Monstad et al. 2008; Cohen et al. 2001). However, the bulk of evidence suggests there is a negative relationship between education and fertility (see Skirbekk 2008 for review of this literature).

changes in fertility behavior, in the offspring's educational distribution, and in the health distribution of the elderly. However, this model does not account for the impact in support ratios and the proportion unhealthy that arise as a consequence of greater longevity or the reduction in infant mortality, due to the lack of suitable data, as we discuss in the last section of the paper.

Our study site: Mexico

We examine the effects of education on elderly health in Mexico, one of the most rapidly aging countries in the world (OECD 2011). Figure 2 presents old-age support ratios in Mexico from 1950 to 2010. Between 1950 and 1970 Mexico experience decrease from 9.5 to 8.5 working age people per elderly; this ratio grew to 9 working age people per elderly by 1990, and decreased dramatically to 6.7 working age people per elderly in 2010, which is slightly above the OECD average of 4.2 (OECD 2011).

<Figure 2>

Rapid increases in life expectancy and decreases in the fertility rate are responsible for this rapid population aging. In Mexico, life expectancy at birth was 75.3 years in 2008 –which corresponds to a 22 years increase over the last 5 decades (OECD 2011), and total fertility rate decreased from over 5.0 in the 1970s to 2.4 children per woman in 2005 (Secretaría de Salud 2005).

Even though Mexico's age structure is changing very rapidly, the country is not well prepared for population aging in terms of old-age pension programs. Kapteyn (2010) shows that less than 2 percent of gross domestic product (GDP) was spent in 1990 and 2005 on publicly funded old-age survivor benefits in this country. Moreover, compared to other OECD countries, Mexico showed the lowest expenditures on these benefits as percentage of GDP. In addition, even though Mexico reformed its pension system in 1997 to reduce the problems associated with population aging, the new system only covers a minority of the population. In this sense, Mexicans still rely on the family to provide care for the elderly population (De Vos et al. 2004).

Mexico also experienced rapid educational expansion in tandem with demographic changes. Women's average years of schooling increased from 5 to 10 for women born between 1925 and 1934 to women born between 1965 and 1971 (Binder and Woodruff 2002). Such a dramatic increase in educational attainment over time is likely to have important implications for population aging; in particular on the configuration of the elderly generation in terms of their health status and on the configuration of their offspring in terms of their education, which need to be accounted for in any discussion of dependency of the old population on the young.

The rapid socioeconomic and demographic changes experienced by the Mexican society, make this case well-suited to study the implications of improvements in education in the support ratios of the population.

Methods

Baseline Model

We use a recursive model of the effect of education on health. In this model, the distribution of elderly women's health is jointly determined by educational attainment, marital status and partner's education, differential fertility, and children's education. The demographic processes that generate the health distribution as a function of education can be modeled as follows:

$$h_{krjl|i} = p^{S}_{k|i}\, r_{ik}\, p^{O}_{j|ik(r-1)}\, p^{H}_{l|ikrj} \qquad (1)$$

where *i*: woman's education, *r*: number of children; ; *(r-1)* number of siblings; *k*: marital status - husband's education, *j*: children's education, *l*: health outcomes

The $h_{krjl|i}$ represents the joint distribution of marital status - husband's education, number of children, offspring's education, and health outcomes conditional on woman's educational attainment. The $p^{S}_{k|i}$ represents the probability distribution of marital status - husband's educational attainment conditional on woman's educational attainment. The r_{ik} is the expected number of children born to couples with woman's education i and husband's education k. The $p^{O}_{j|ik(r-1)}$ is the probability distribution of offspring's educational attainment conditional on woman's education i, marital status - husband's education k, and the number of siblings r for children of these couples. Finally, the $p^{H}_{l|ikrj}$ is the distribution of health outcomes conditional on woman's education i, marital status - husband's education k, the number of children r, and children's education j.

We estimate four equations separately. First, for the marriage process, we estimate the coefficients of a multinomial logistic regression to calculate the probability distribution of marital status conditional on women's education ($p^{S}_{k|i}$). Second, to model fertility behavior, we estimate the coefficients of a poisson regression to calculate expected number of children conditional on marital status - husband's education and women's education (r_{ik}). Third, the intergenerational transmission of education process is modeled using an ordinal logistic regression to estimate the probability distribution of offspring's education conditional on number of siblings, marital status - husband's education, and mother's education ($p^{O}_{j|ikr}$). Finally, we estimate the coefficients of a binary logistic regression to calculate the probability distribution of health status conditional on women's education, marital status - husband's education, offspring's education, and number of children ($p^{H}_{l|ikrj}$).

The estimated parameters are used to estimate each conditional probability in equation (1). Using the estimated $\hat{h}_{krjl|i}$ and observed marginal distribution of women's educational attainment, the expected marginal distribution of women's health outcomes in old age is estimated in the following way:

$$\hat{H}_l = \sum_{i=1}^{i} \sum_{k=1}^{k} \hat{h}_{krjl|i} W_i \quad (2)$$

where $\hat{H}_l$ is the distribution of expected elderly health and W_i are marginal distributions of own educational attainment respectively.

The predicted probability distributions of offspring's educational attainment, and health status of the elderly, as well as, the expected number of children are used to compute the GSRs for a baseline scenario.

Simulations

We compute $\hat{h}_{krjl|i}$ for different scenarios that vary by (a) changes in the education distribution of women, (b) the presence or absence of changes in the distributions associated we the demographic processes (i.e. $p^S_{k|i}, r_{ik}, p^O_{j|ikr}$). By conducting simulations, in which each or some of the demographic processes are held constant, we are able to show how these processes improve or worsen elderly health, and what is the contribution of each demographic process on changes in GSRs.

After simulating the health distribution, we compute two different ratios. First, we compute the ratios of simulated proportion healthy to the baseline (observed) proportion healthy. If the ratios are greater than 1, this means that improvements in educational attainment lead to improvements in health among the elderly. These ratios, computed in various conditions in which intervening demographic mechanisms are present or absent, show the proportional changes in the share of the healthy elderly and the contribution of each demographic element to such changes. We compute simulated GSR to baseline GSR to assess how changes in educational attainment in one generation lead to changes in the generational support structure of the population.

Because key measures in simulation analyses are based on the parameter estimates from four different regression analyses, it is difficult to assess sampling variability analytically. Hence, we use a bootstrapping method to compute standard errors (Efron and Tibshirani 1993). First, we resample 1,000 bootstrap samples with replacement from the original data set because 1,000 replications are sufficient to compute a reliable confidence interval (Efron and Tibshirani 1993). Second, we compute for each bootstrap sample the four set of regressions and compute predicted probability distributions and the expected number of children needed to estimate GSRs. Third, based in this information, we compute for each sample (i) ratios of simulated proportion healthy to baseline proportion healthy and (ii) simulated GSRs to baseline GSRs. Finally, we estimate standard errors of estimates by computing the standard deviations of these ratios.

Data

We use the Mexican Health and Aging Study (MHAS), a longitudinal study of health and aging in Mexico, with national and urban-rural representations. The baseline survey was conducted in 2001 and is representative of the non-institutionalized Mexican population of year 2000, aged 50 and over and their spouse/partners regardless of their age. The sample size is of 9,862 households with around 15,000 individuals and covers all 32 states in Mexico[4] (ENASEM 2004). The MHAS includes a wide array of information such as socio-demographic characteristics, family composition, fertility, and health outcomes. To account for the survey design we used sampling weights in the descriptive analysis of the variables and in all regression models. We add to the regressions controls for age, rural residence, and living in a high migration state.

Analytical sample

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[4] Information is available at:
http://www.mhas.pop.upenn.edu/english/documents/Methodological/Doc_metodologico-v2.pdf

Our sample includes women older than 60 years old at baseline: a total of 3,829 eligible respondents. Of the 3,829 original respondents, 9% were dropped due to missing data on one or more of the health outcomes, and 1% were dropped due to missing data on number of children or on children's educational attainment, resulting in an analytical sample of 3,427 women. We explore mis-representativeness due to missing data by calculating a logistic regression to estimate the odds of missing data on demographic characteristics and find that education, marital status, rural residence, and living in a high migration state are not associated with non-response. However, we find that women of age 80+ are 2.8 times more likely to be missing in the sample compared to youngest group of women.

We construct two analytical samples. The first sample is used for the health, marriage, and fertility models and consists of women age 60 or older. The second sample is used for the intergenerational transmission of education model and consists of the offspring of the women in the first sample. Childless women do not contribute any observation in this sample. The second sample has 18,374 observations. Offspring younger than 18 years old were assigned the average educational level of their older children[5].

We use three different measures of health outcomes: self-reported health (SRH), difficulty in performing activities of daily living (ADLs), and difficulty in performing instrumental activities of daily living (IADLs). We dichotomize SRH in good health ("excellent", "very good" and "good") and other ("fair" and "poor"). In developed countries, SRH has been shown to be a strong predictor or mortality and morbidity (Idler & Benyamini 1997). We use two measures of functional limitations: difficulty in performing ADLs and difficulty in performing IADLs. The ADLs items include walking within a room, bathing, eating, getting up of bed and

[5] Only 2% of women in the sample had at least one offspring aged less than 18 years.

lying down, and using toilet. The IADLs items include preparing a hot meal, shopping, managing money, and taking medications. We classify respondents as functionally limited in ADLs or in IADLs if they report at least one limitation in any of their items. These two measures of functional limitations capture more objective health conditions and measure different aspects of independent living among the elderly (Wiener et al. 1990).

We classify women's educational attainment in four categories: no instruction, 1 to 6 years of schooling, 7 to 11 years of schooling, and 12+ years of schooling. Marital status is classified in eight categories. For our model, the relevant categories are: never married, married to a husband with no instruction, 1 to 6 years of schooling, 7 to 11 years of schooling, and 12+ years of schooling. The sixth category classifies widows (38%), and the seventh category the separated or divorced (9%). Adding these categories in the health, fertility, and transmission models is equivalent to imputing husband's education by replacing missing values with the sample average of husband's education and including a dummy indicating if the value is missing (Allison 2001). We follow this procedure to keep the observations with missing information on husband's education.

To capture the educational distribution of younger cohorts, we classify offspring's education in four categories: less than 6 years of schooling, 7 to 9 years of schooling, 10 to 12 years of schooling, and 13 years of schooling or more. In the health model, we use the percent of children in each educational category as a measure of offspring's education. For childless women (who represent 7% of the sample) we set the four categories equal to zero. This specification is equivalent to a "dummy variable adjustment" method in handling missing data (see Allison 2001: 9-11).

We assembled number of children for each woman by adding the number of resident and non-resident children in the sample. We only include surviving children.

Results

Descriptive Results

Table 1 shows descriptive statistics of the two samples. Means, standard deviations and percentages shown in this table are weighted to represent estimates at the population level; the number of observations is unweighted.

<Table 1>

The first column of Table 1 shows summary statistics of Mexican elderly women older than 60. First, we observe that most of the women have low educational attainment levels (87% has less than 7 years of education). Second, about 8% of the women never married, 46% are married, 10% are separated or divorced, and 36% are widowed. Third, husbands' educational attainment is fairly low (18% of women marry husbands with no schooling and 22% marry husbands with 1 to 6 years of education). Fourth, on average these women have 5.2 surviving children. Fifth, around 29% reported having good health. About 89% and 85% of these women reported not having difficulties performing ADLs nor IADLs, respectively. The difference between the subjective measure of health (SRH) and more objective measures (ADLs and IADLs) is noteworthy. This is consistent we previous research that suggests that as people age the difference between perceived health and more objective measures tend to broaden (Nybo et al. 2001; Johnson et al. 1993).

The second column of Table 1 shows statistics for the sample used in the transmission model. The sample consists of the elderly women's offspring. In this sample, women with more surviving children are represented more times. In general, mothers in this sample are slightly younger, less educated, more likely be married, more likely to have less educated husbands, and more likely to be widowed compared to women's in the first sample. Their offspring shows low levels of educational attainment (51% with less than 7 years of education, and 28% between 7 to 11), and they have on average 6.2 siblings.

Regression Analyses

Tables A1, A2, and A3 of the Appendix show the results for the marriage, fertility, and health models. In terms of marriage behavior, (see Table A1) we find a pattern of educational homogamy among married women, with the exception of those with 7 to 11 years of education, who show a pattern of educational hypergamy. Additionally, we find that the probability of remaining single increases for women with higher educational attainment compared to women with lower educational attainment. This finding is consistent with the hypothesis that improvements in women's education may lessen the incentives to marry due to a reduction in marriage returns.

In terms of fertility behavior, (see Table A2) in general we find a negative relationship between women's education and fertility. Overall, we do not find a significant relationship between husband's education and fertility. We also find that never married women show the lowest fertility levels.

The intergenerational transmission of education model (see Table A2) shows that offspring's education is strongly associated with parental education. Having one sibling more is associated with a 5% [$100\times (1-e^{-0.06})$] decrease in the odds of attaining a higher educational category, net of the other variables in the model.

The health model (see Table A3) shows educational gradients in health in terms of all health measures[6]. The results also show that marrying husbands with higher education, as well as, not marrying anyone, is associated with better women's health only in terms of IADLs[7]. We do not find any effects of offspring's education on SRH nor on ADLs; however, we do find a positive effect in terms of IADLs. We find that having an additional child decreases the odds of reporting good health, in terms of SRH, by 6%, holding the other variables in the model constant.

Based on the regression models, we proceed to conjecture how changes in the distribution of women's educational attainment may affect the elderly health distribution and the GSRs.

Scenarios

Our simulations consist of changing 5% of women from lower to higher educational categories according to two different scenarios:

1 – Change in women's education from 0 to 12+ years of education

2 – Change in women's education from 1-6 to 7-11 years of education

We conjecture first that improvements in women's education will lower incentives to marry and lead to marriages with better educated husband's due to educational homogamy. Second, this improvement will be associated with a reduction in fertility, which will be further enhanced by the increase in the proportion of never-married women. Third, improvements in parental education and reduction in the number of siblings may lead to improvements in offspring's educational attainment.

Given the existence of educational gradients on health, these changes may improve the elderly health distribution, which will be further enhanced by improvements in husbands' and

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[6] Wald tests confirm a significant association between women's education and health (p=0.000).

[7] Wald tests show that husband's education does not have an effect on SRH (p=0.115), but it does have an effect on ADLs (p=0.001) and IADLs (p=0.014).

offspring's education in terms of SRH and IADLs. Subsequent fertility reductions may worsen the health distribution in terms of SRH.

In terms of GSRs, upgrading women's education will decrease the number of offspring per elderly. However, the directions of the changes in the other GSRs are not straightforward. For example, expected improvements in offspring's education may increase the ratio of more educated offspring per elderly, however, the increase in this ratio may be dampened by the reduction in total fertility. Moreover, the direction of the change in the ratio of offspring per unhealthy elderly will depend in the relative change in the number of unhealthy elderly (which is expected to decrease), and the number of offspring (which is also expected to decrease).

Simulations

Figure 4 shows ratios of simulated proportion healthy to the baseline proportion healthy for the two scenarios. Figures 5 to 7 show ratios of simulated GSRs to baseline GSRs. Ratios greater than 1 mean that simulated changes in educational attainment lead to an increase in the proportion healthy or in the GSRs. Box plots are presented to show point estimates of these ratios along with sampling variability, which is estimated by a bootstrap method. The box plots show the medians (lines in the middle), the 25 and 75 percentiles (boxes), and 1.5 time interquartile ranges (outer lines). We consider that a ratio is statistically significant if the 1.5 interquartile range does not include 1.

Furthermore, within each scenario, we made several assumptions regarding the demographic processes involved. As indicated at the bottom of the Table, *M* represents marriage behavior, *F* is differential fertility, and *T* is intergenerational transmission of education. *N* indicates the absence of respective elements. For example, *M_F_T* simulation assumes that changes in women's education lead to subsequent changes in husband's education, number of children, and children's education. By contrast, in *NM_NF_NT* simulation, none of these changes occur.

Changes in proportion of healthy elderly

<Figure 3>

In terms of SRH, most of our conjectures are supported. First, an improvement in women's education has a direct positive effect in elderly health. For example, in scenario 1 the NM_NF_NT simulation shows that if we improve the educational attainment of 5% of these women, from 0 to 12+ years of education, the proportion healthy would increase by 6%. We get similar results for scenario 2, however, since changes in women's education are not as dramatic as in scenario 1, improvements are lower.

Second, we find that demographic processes enhance health distributions. For example, we find that changes in fertility behavior, due to upgrading women's education from 0 to 12+ years of education, increases the proportion of healthy elderly women by 0.50% (i.e. without taking into account changes in marriage behavior, and changes in offspring's education) (1.069 in NM_F_NT minus 1.064 in NM_NF_NT). This is the case because fertility is negatively associated with health status. In this same scenario, we find that taking into account only changes in offspring's educational attainment the proportion healthy increases by 0.80%; and if we only consider the changes in marriage behavior (i.e. due to the reduction in incentives for marriage and the presence of educational homogamy) this proportion increases by 1%. By taking into account all the demographic processes (see M_F_T) the initial improvement in the proportion healthy is boosted by 2.20% in the first scenario and by 1% in the second. Moreover, the demographic factor that contributes most importantly to this boost in the health distribution is the change in marriage behavior.

Third, by comparing the two scenarios we find that the magnitude of the contribution of these demographic processes to the improvement in elderly health is stronger if the improvement in women's education involves greater changes in the educational attainment of women.

In terms of ADLs, we find that improvements in women's education have a slight positive effect in the health distribution. For ADLs, the proportion healthy increases 0.4% and 0.3% in scenarios 1 and 2, respectively (see NM_NF_NT). However, the results indicate that the demographic processes involved in the simulations do not have any further effects on the health distribution in terms of ADLs. This is the case because most of the intermediate demographic variables (i.e. the number of offspring and offspring's education) are not significantly associated with the ADLs.

In terms of IADLs, we find that improvements in women's education improve the proportion healthy by 0.6%, only in the first scenario. Furthermore, changes marriage behavior increases the proportion health by an additional 0.1%.

Simulation Results: Changes Generational Support Ratios

<Figure 4 >

Figure 4 shows that improvements in women's education reduce the number of total offspring per elderly. Moreover, we find substantial increases in the number of offspring with college or more per elderly (e.g. by 11.6% in scenario 1). These improvements result from the strong contribution of the intergenerational transmission of education (see NM_NF_T). These results suggest that the elderly population can be supported by a better-educated offspring.

<Figures 5, 6 and 7 >

In terms of SRH, Figure 5 shows that improvements in women's education reduce the proportion unhealthy in the population, increases the number of total offspring per unhealthy elderly by 2.8% in the scenario 1 (see NM_NM_NT). Moreover, after taking into account the changes in demographic processes, we find that the increase in the support ratio is no longer significant. A similar pattern is observed in terms of ADLs and IADLs (see Figures 6 and 7).

In addition, we find that changes in demographic behaviors contribute significantly in the change of the number or offspring with college or more per unhealthy elderly. Again, transmission is the main contributor in the change of this ratio. For example, in terms of SRH, upgrading women's education from 0 to 12+ years of education boosts the number of offspring with college or more per unhealthy elderly from 2.8% to 13.2%. In terms of ADLs and IADLs we also observe a similar pattern. Even though ADLs are not significantly related to demographic behaviors at the micro-level, at the population level upgrading women's education leads to important changes in the offspring's configuration that affect significantly the number of college educated offspring per unhealthy elderly.

Summary and discussion

Our study estimate GSRs to examine the dependency of older generations to new generations, taking into account health heterogeneity in the older population and education heterogeneity in the offspring generation.We measure health using three outcomes: SRH, difficulties performing ADLs and IADLs.

We use a nationally representative sample of ever-married women older than 60 years in Mexico. Through a series of simulations consisting of changing 5% of women from lower to higher educational categories, according the two different scenarios, we answer the following question: What would be the effect of a public policy that changes the education of a targeted subgroup of women, when they are young, in their own health, when they become older? At the individual level, such a policy is very likely to have a positive effect on women's health, given the existence of educational gradients in health. At the population level, the effect of such a policy is not straightforward because changes in woman's educational attainment may alter if she marries, whom she will marry, the number of children she will bear, and the education of her surviving children, which, altogether, may affect woman's health when the become older. Our results show that upgrading women's education have a direct positive effect in women's health distribution when the educational upgrading involves greater changes in the educational attainment of women. The effects in the health distribution of the elderly are larger in terms of SRH than in terms ADLs and IADLs.

By accounting for the changes in demographic behaviors, we find that the health distribution is further enhanced in terms of SRH and IADLs. However, demographic behaviors do not have further effects on the health distribution in terms of ADLs. We find that the main intermediate demographic process driving up the proportion healthy is associated with the improvements in offspring's education. Furthermore, subsequent fertility reductions decrease the number offspring per elderly. However, the number of offspring with college or more per elderly is boosted by the improvements in offspring's education. This result suggests that by upgrading women's education the elderly population can rely on their better-educated offspring for their support.

Additionally, we find that improvements in women's education reduce the proportion unhealthy in the population, which increases the ratio of total offspring per unhealthy elderly. It is striking the impact that changes in demographic behaviors have on GSRs. In scenario 1, for all health outcomes, the ratio in the number of college educated offspring per unhealthy elderly increases in about 12% if demographic behaviors are taken into account. Again, improvement in offspring's education is the main factor driving up this ratio.

We suggest that policy discussions about the future requirements of the elderly population need to rely on support ratios that take into account the characteristics of the elderly and of the offspring that will provide for them.

Our study has several limitations. First, our results cannot be generalized to the entire population because our sample includes only female respondents. Second, at the individual level, the model assumes that education is exogenous and that husband's education, number of children, offspring's education, and women's health status are endogenous. However, these assumptions may not reflect reality because the relationship between (i) women's and husbands' education, (ii) women's education and number of children, and (iii) women's education and health, may not be causal (Logan et al. 2008; Schmidt 2008; Angrist and Pischke 2009). Nonetheless, the model assumes that education is exogenous to illustrate the demographic pathways through which education may affect health. Third, at the population level, the model assumes that changes in the distribution of educational attainment affect the age structure of the population. However, we know that changes in the age structure of the population may lead to changes in educational attainment (Lee and Mason 2010). We do not intend to establish causality between education and age structure. Nevertheless, by assuming that changes in the educational distribution are exogenous, we are able to show how differential demographic behaviors affect population support ratios. Finally, our model do not account for the effect of differential mortality by education. In particular, we know that improvements in educational attainment may lead to increases in the number of survivors in old age and the number of surviving offspring. However, this model does not account for the impact in support ratios and the proportion unhealthy that arise as a consequence of greater longevity or the reduction in infant mortality, due to lack of suitable data for Mexico. In particular, we would need information on the joint distribution of survival chances, health status, own and spousal education, and the number and educational attainment of offspring. Nonetheless, the model used in this study provides a framework that allows integrating the impact of demographic processes in the complex relationship that exists between education, health, and support ratios.

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Table 1: Descriptive Statistics*

	Women Sample	Clustered Sample
Age (%)		
60-64	33.9	35.2
65-69	24.7	25.8
70-74	16.8	17.0
75-79	11.7	11.2
80+	12.9	10.8
Total	100.0	100.0
Rural (%)	54.0	58.4
High Migration States (%)	20.2	23.4
Women's education (%)		
0	43.3	45.7
1-6	43.8	46.0
7-11	8.7	6.2
12+	4.2	2.1
Total	100.0	100.0
Marital Status - Husband's Education (%)		
Married 0	17.7	21.6
Married 1-6	22.1	25.2
Married 7-11	3.6	2.8
Married 12+	2.8	1.9
Never-Married	7.9	3.5
Widowed	35.8	36.3
Separated/Divorced	10.2	8.8
Total	100.0	100.0
# of offspring (s.d.)	5.2 (3.28)	
# of siblings (s.d.)		6.2(2.88)
Offspring's Education (%)		
0-6	-	51.0
7-11	-	28.4
12	-	5.4
13+	-	15.2
Total	-	100.0
Health (%)		
SRH=good	29.2	-
No ADLs	89.7	-
No IADLs	85.6	-
Observations (n)	3,427	18,374

* Weighted percent, mean and standard deviation, and unweighted number of observations.

Source: Mexican Health and Aging Study wave 2001

Figure 1: Demographic Model

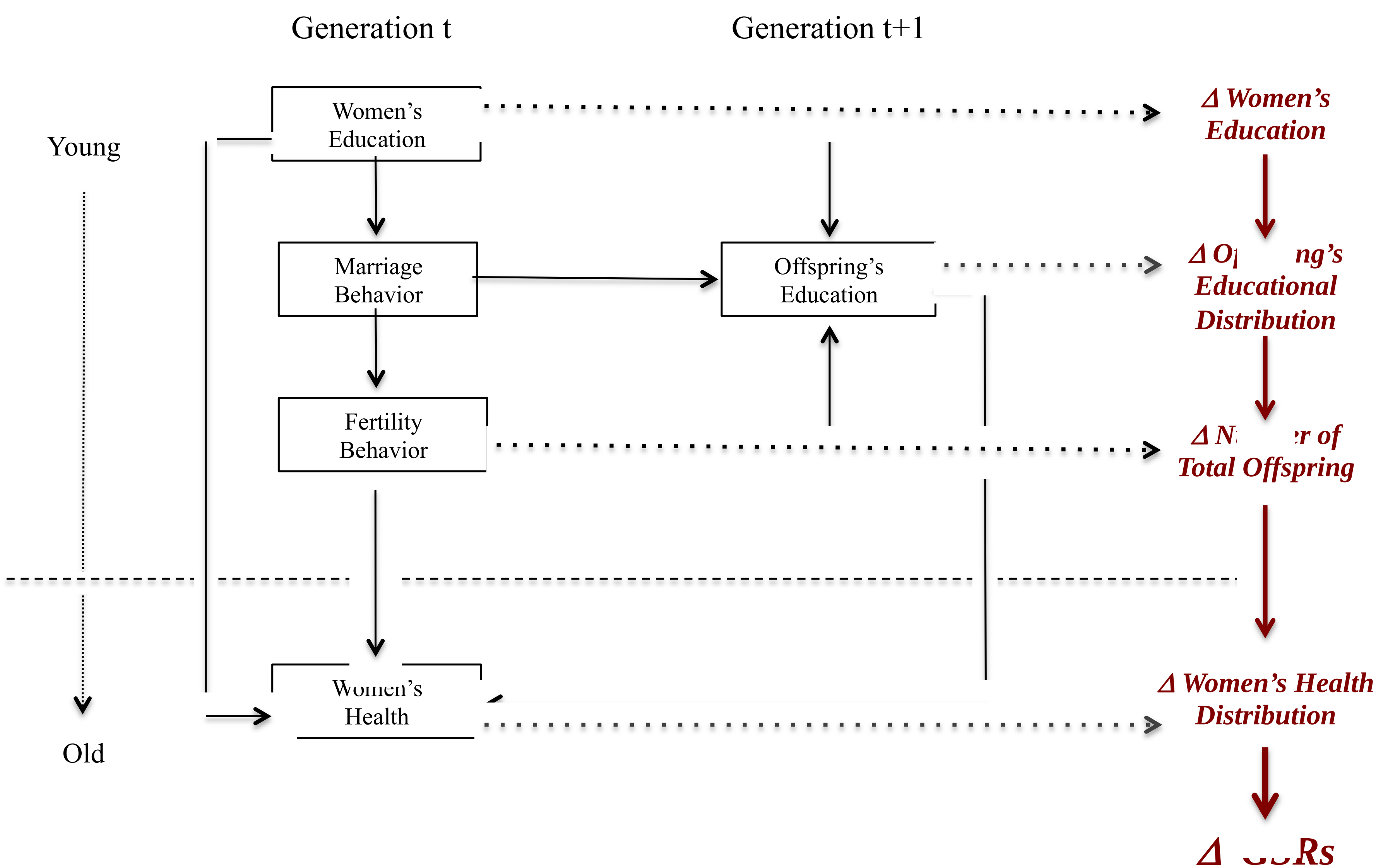
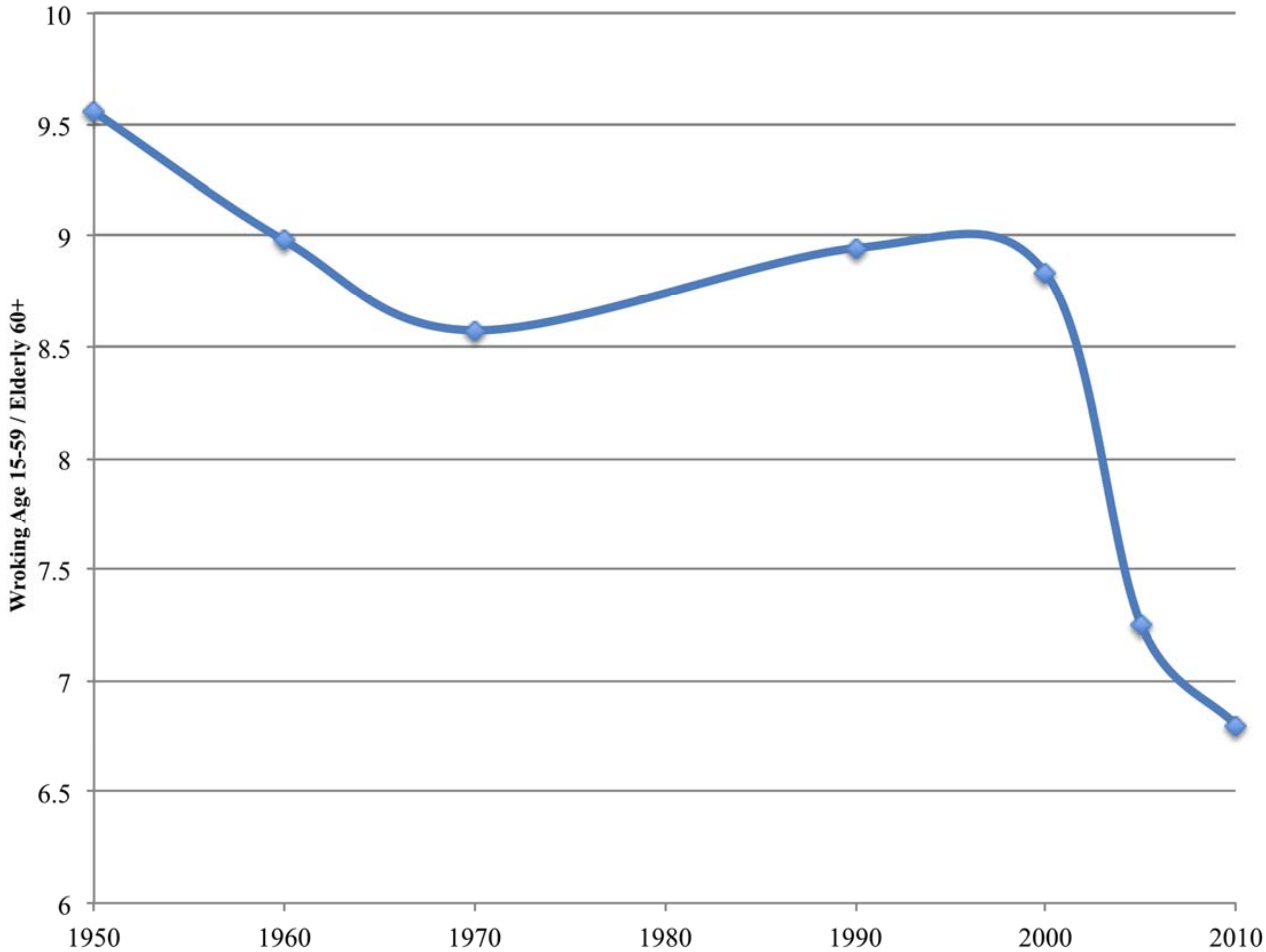


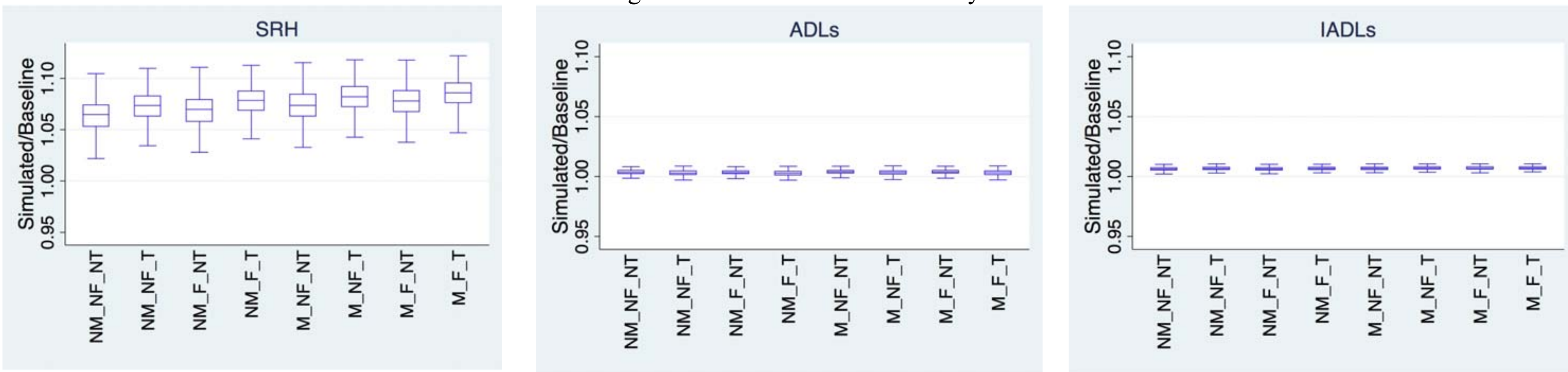
Figure 2: Old-Age Support Ratio in Mexico 1950-2010



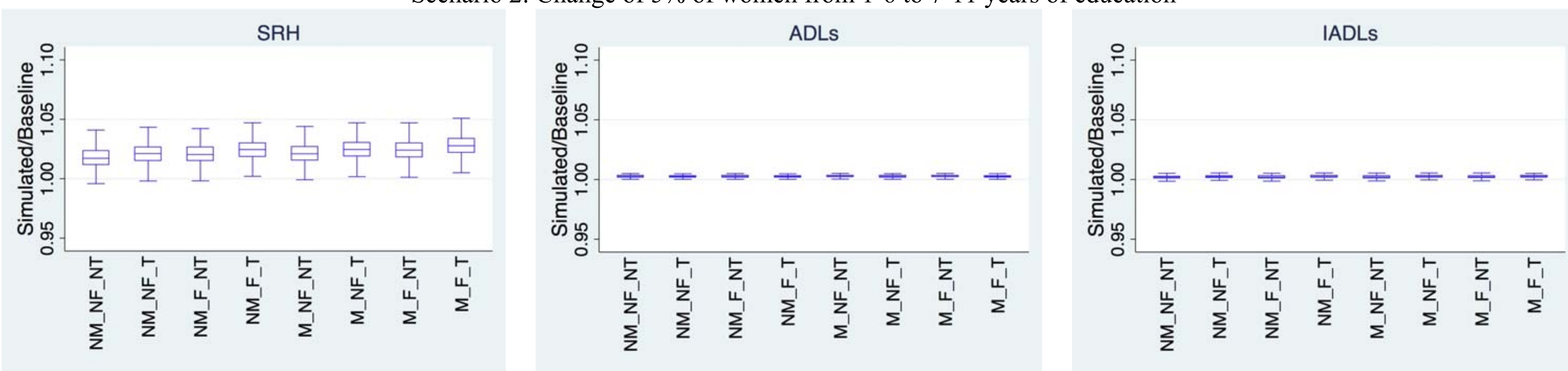
***Source*: INEGI**

Figure 3. Ratios of simulated to baseline proportion healthy

Scenario 1: Change 5% of women from 0 to 12+ years of education



Scenario 2: Change of 5% of women from 1-6 to 7-11 years of education

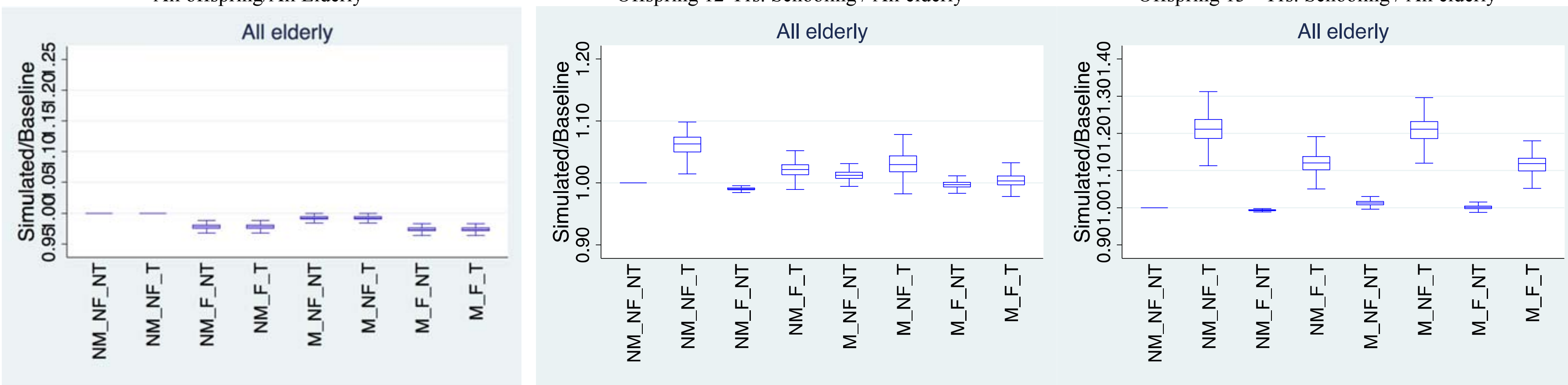


Notes:
(1) *M:* marital status and assortative marriage; *F:* differential fertility; *T:* intergenerational transmission of education; *N:* absence of each element.
(2). Box plots show medians (lines in the middle), the 25 percentiles and the 75 percentiles (boxes), 1.5 time interquartile ranges (outer lines).
(3) Sampling variability estimated by a bootstrap method (1, 000 replications)

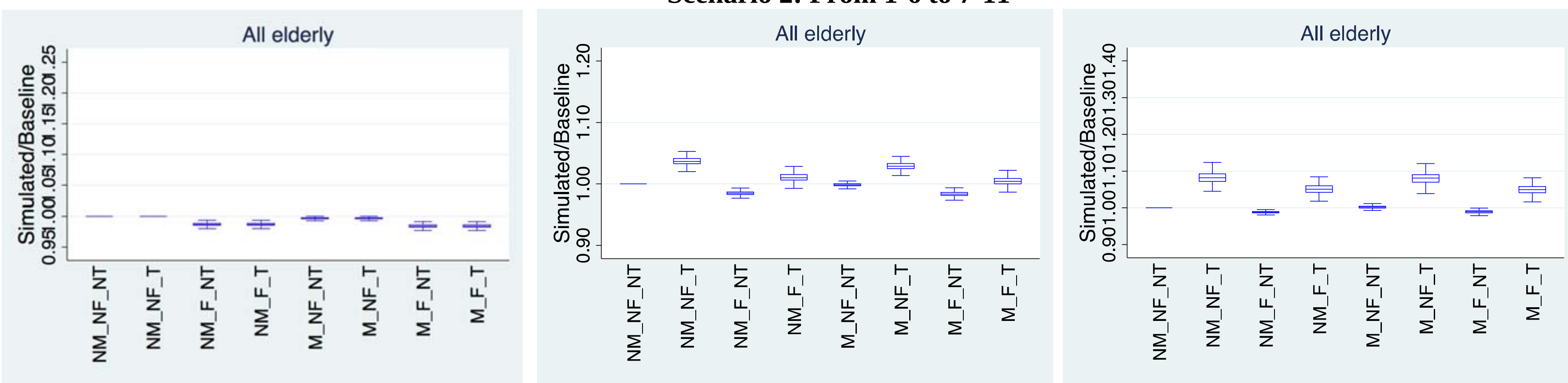
Figure 4. Ratios of Simulated GSR/Baseline GSR

Scenario 1: From 0 to 12 +

All offspring/All Elderly | Offspring 12 Yrs. Schooling / All elderly | Offspring 13+ Yrs. Schooling / All elderly



Scenario 2: From 1-6 to 7-11



***Source:** Mexican Health and Aging Study wave 2001*

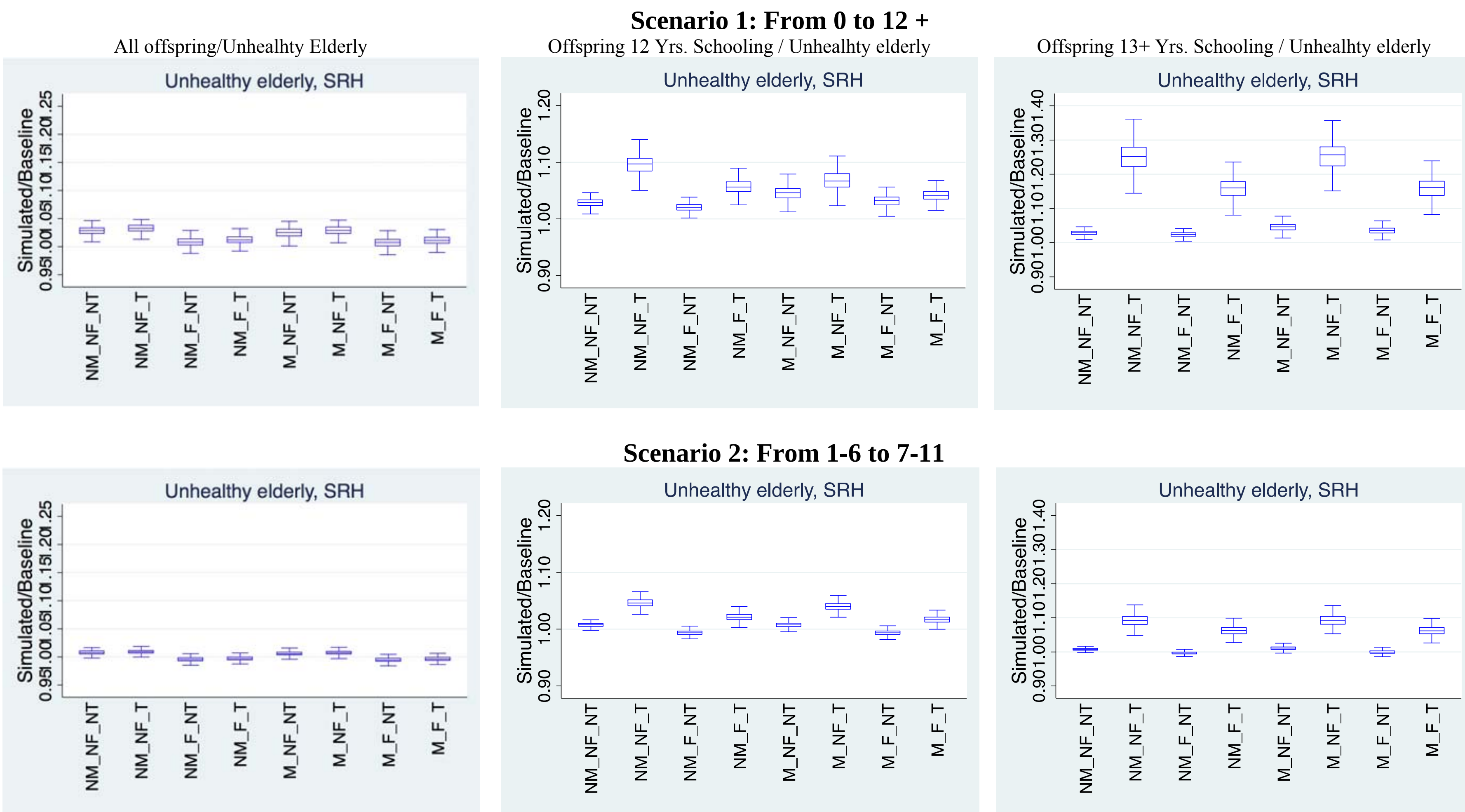
Notes:

(1) *M:* marital status and assortative marriage; *F:* differential fertility; *T:* intergenerational transmission of education; *N:* absence of each element.

(2). Box plots show medians (lines in the middle), the 25 percentiles and the 75 percentiles (boxes), 1.5 time interquartile ranges (outer lines).

(3) Sampling variability estimated by a bootstrap method (1, 000 replications)

Figure 5. Simulated GSR/Baseline GSR in terms of SRH



Source: *Mexican Health and Aging Study wave 2001*

Notes:

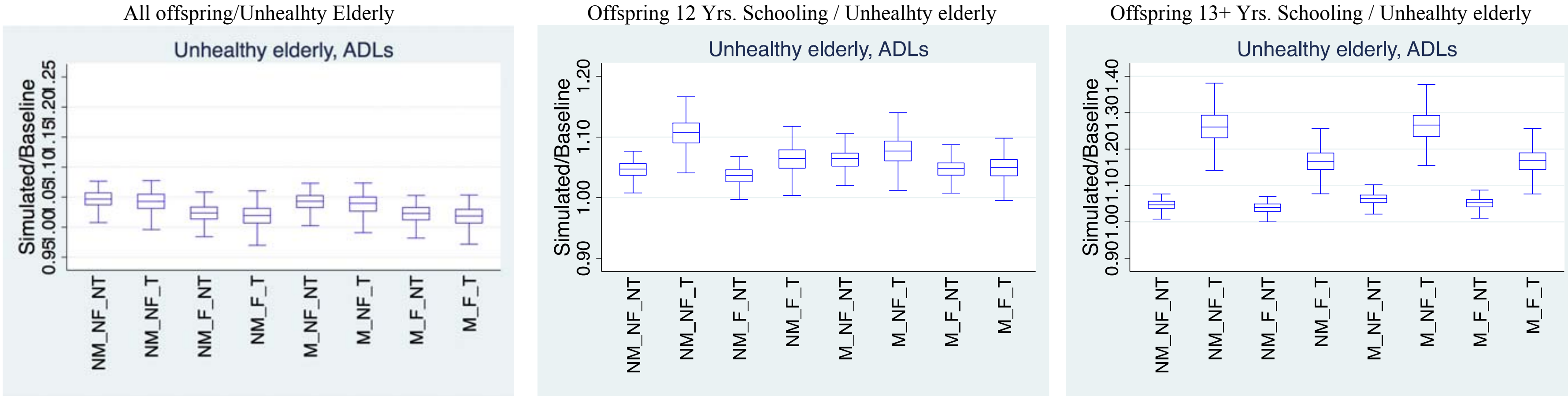
(1) *M:* marital status and assortative marriage; *F:* differential fertility; *T:* intergenerational transmission of education; *N:* absence of each element.

(2). Box plots show medians (lines in the middle), the 25 percentiles and the 75 percentiles (boxes), 1.5 time interquartile ranges (outer lines).

(3) Sampling variability estimated by a bootstrap method (1, 000 replications)

Figure 6. Simulated GSR/Baseline GSR in terms of ADLs

Scenario 1: From 0 to 12 +



Scenario 2: From 1-6 to 7-11

Source: *Mexican Health and Aging Study wave 2001*

Notes:

(1) *M:* marital status and assortative marriage; *F:* differential fertility; *T:* intergenerational transmission of education; *N:* absence of each element.

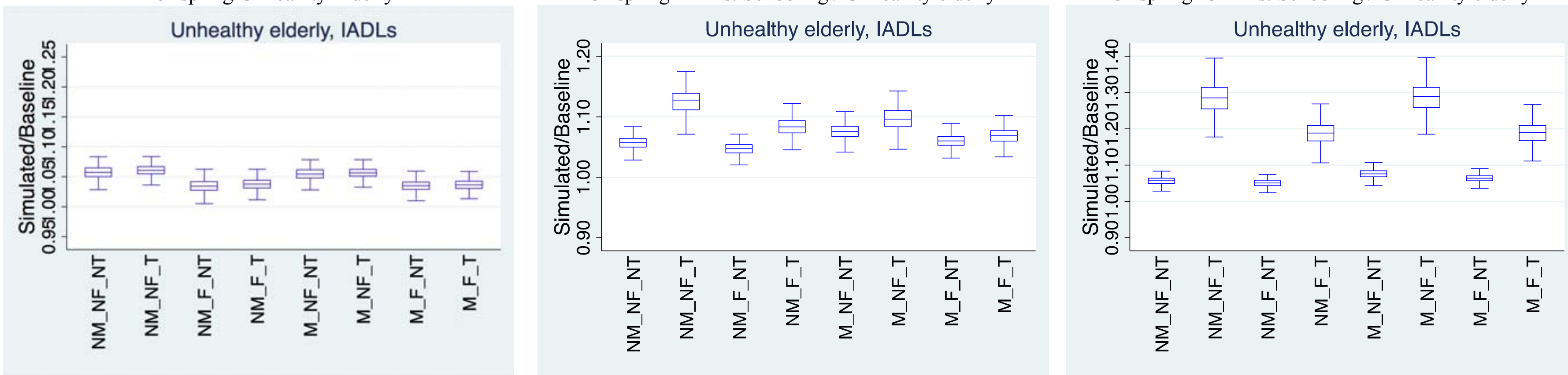
(2). Box plots show medians (lines in the middle), the 25 percentiles and the 75 percentiles (boxes), 1.5 time interquartile ranges (outer lines).

(3) Sampling variability estimated by a bootstrap method (1, 000 replications)

Figure 7. Simulated GSR/Baseline GSR in terms of IADLs

Scenario 1: From 0 to 12 +

All offspring/Unhealhty Elderly | Offspring 12 Yrs. Schooling / Unhealhty elderly | Offspring 13+ Yrs. Schooling / Unhealhty elderly



Scenario 2: From 1-6 to 7-11

Source: *Mexican Health and Aging Study wave 2001*

Notes:

(1) *M:* marital status and assortative marriage; *F:* differential fertility; *T:* intergenerational transmission of education; *N:* absence of each element.

(2). Box plots show medians (lines in the middle), the 25 percentiles and the 75 percentiles (boxes), 1.5 time interquartile ranges (outer lines).

(3) Sampling variability estimated by a bootstrap method (1, 000 replications)

Table A1: Multinomial logistic regression of marital status on women's education of a sample of Mexican women's older than 60

Variables	Married 12+ versus Married no schooling β	p-value	Married 12+ versus Married 1-6 education β	p-value	Married 12+ versus Married 7-11 education β	p-value
Age						
60-64	-	-	-	-	-	-
65-69	-0.12	0.821	0.37	0.474	-0.76	0.179
70-74	0.55	0.312	0.18	0.731	0.58	0.358
75-79	0.11	0.892	0.05	0.948	-0.78	0.350
80+	1.78	0.116	1.13	0.340	3.23	0.014
Rural	1.44	0.020	1.14	0.062	0.40	0.579
High Migration States	1.47	0.002	1.00	0.035	0.80	0.139
Women's education						
0	-	-	-	-	-	-
1-6	-3.94	0.000	-2.19	0.005	-1.19	0.222
7-11	-7.09	0.000	-4.17	0.000	-1.16	0.234
12+	-30.6	0.000	-7.58	0.000	-2.18	0.058
Constant	4.8	0.000	4.41	0.000	1.44	0.146
Log Pseudolikelihood		-5247997.9				

Variables	Married 12+ versus Never married β	p-value	Married 12+ versus Widowed β	p-value	Married 12+ versus Separated Or Divorced β	p-value
Age						
60-64	-	-	-	-	-	-
65-69	-0.16	0.775	0.55	0.295	0.12	0.829
70-74	0.90	0.115	1.46	0.004	0.25	0.659
75-79	1.07	0.200	1.48	0.047	0.26	0.748
80+	2.01	0.086	3.70	0.001	2.36	0.037
Rural	1.22	0.056	0.69	0.253	0.57	0.360
High Migration States	1.72	0.001	1.01	0.030	0.51	0.309
Women's education						
0	-	-	-	-	-	-
1-6	-2.89	0.00	-2.99	0.00	-2.98	0.00
7-11	-3.58	0.00	-4.30	0.00	-3.64	0.00
12+	-4.90	0.00	-6.51	0.00	-5.75	0.00
Constant	3.26	0.00	4.86	0.00	4.30	0.00
Observations (n)	3,427					

* Weighted regression

Source: Mexican Health and Aging Study wave 2001

Table A2: Parameter Estimates for fertility and transmission regression models*

	Fertility (Poisson)			Offspring Education (Ologit)		
	β	z	p-value	β	z	p-value
Age						
60-64	-	-	-	-	-	-
65-69	-0.01	-0.22	0.827	-0.10	-0.74	0.461
70-74	-0.05	-0.83	0.406	-0.28	-1.99	0.047
75-79	-0.10	-1.85	0.065	-0.52	-3.28	0.001
80+	-0.23	-3.25	0.001	-0.78	-2.88	0.004
Rural	0.10	2.83	0.005	-0.76	-7.19	0.000
High Migration States	0.18	4.86	0.000	-0.50	-4.50	0.000
Women's education						
0	-	-	-	-	-	-
1-6	0.02	0.45	0.656	1.09	9.35	0.000
7-11	-0.28	-4.13	0.000	2.28	11.60	0.000
12+	-0.55	-4.30	0.000	3.52	7.23	0.000
Marital Status - Husband's Education						
Married 0	-	-	-	-	-	-
Married 1-6	-0.04	-0.83	0.408	0.55	3.41	0.00
Married 7-11	-0.17	-1.55	0.122	1.28	4.84	0.00
Married 12+	-0.19	-1.41	0.159	1.47	4.11	0.00
Never-Married	-0.95	-6.67	0.000	0.47	1.52	0.13
Widowed	-0.09	-1.76	0.078	0.20	1.44	0.15
Separated/Divorced	-0.23	-3.38	0.001	0.23	1.15	0.25
# of siblings				-0.06	-2.72	0.01
Constant	1.76	30.45	0.000			
Cut points						
cut point 1				-0.08	0.18	
cut point 2				1.63	0.19	
cut point 3				2.09	0.20	
Log Pseudolikelihood		-9472557.2			-17988.09	
Observations			3,427			18,374

* Weighted regressions

Source: Mexican Health and Aging Study wave 2001

Table A3: Coefficients (p-values) for logit regression models of the association between women's education and health

	SRH				ADLs				IADLs			
	Gross Effect	p-value	Net Effect	p-value	Gross Effect	p-value	Net Effect	p-value	Gross Effect	p-value	Net Effect	p-value
Age												
60-64	-	-	-	-	-	-	-	-	-	-	-	-
65-69	-0.29	0.12	-0.26	0.16	-0.28	0.31	-0.25	0.35	-0.65	0.03	-0.59	0.05
70-74	-0.18	0.36	-0.16	0.43	-0.04	0.88	-0.01	0.98	-0.64	0.02	-0.54	0.06
75-79	-0.77	0.00	-0.77	0.00	-0.63	0.04	-0.59	0.06	-1.13	0.00	-0.99	0.00
80+	-0.42	0.10	-0.46	0.09	-1.62	0.00	-1.54	0.00	-2.49	0.00	-2.26	0.00
Rural	0.02	0.91	0.11	0.50	0.48	0.02	0.46	0.02	0.72	0.00	0.78	0.00
High Migration States	-0.39	0.02	-0.32	0.05	-0.34	0.08	-0.36	0.07	-0.03	0.89	0.03	0.87
Women's education												
0	-	-	-	-	-	-	-	-	-	-	-	-
1-6	0.33	0.04	0.24	0.16	0.36	0.08	0.30	0.14	0.38	0.06	0.21	0.32
7-11	1.08	0.00	0.70	0.01	1.23	0.00	1.25	0.00	1.10	0.01	0.74	0.10
12+	2.29	0.00	1.74	0.00	1.44	0.07	1.26	0.04	2.80	0.00	1.82	0.00
Marital Status - Husband's Education												
Married 0			-	-			-	-			-	-
Married 1-6			0.11	0.65			0.48	0.14			0.52	0.12
Married 7-11			0.91	0.02			2.93	0.00			2.14	0.00
Married 12+			0.13	0.77			-0.03	0.96			1.22	0.05
Never-Married			0.34	0.31			0.58	0.13			0.95	0.02
Widowed			0.02	0.92			0.12	0.65			-0.05	0.88
Separated/Divorced			0.27	0.31			-0.01	0.99			0.20	0.62
# of offspring			-0.06	0.02			0.01	0.82			-0.02	0.63
Offspring's Education												
0-6			-	-			-	-			-	-
7-11			0.00	0.64			0.00	0.82			0.00	0.95
12			0.00	0.88			0.00	0.78			0.04	0.00
13+			0.00	0.14			0.00	0.36			0.00	0.84
Constant	-0.95	0.00	-0.85	0.00	2.19	0.00	2.00	0.00	2.05	0.00	1.79	0.00
Log Pseudolikelihood	-2060905.1		-2030063.0		-1116098.50		-1101120.30		-1292789.60		-1251966.20	
Observations (n)	3,427											

* Weighted regressions

Source: Mexican Health and Aging Study wave 2001