Published in final edited form as:

Res Aging. 2016 April ; 38(3): 299–321. doi:10.1177/0164027515620243.

Educational Gradients and Pathways of Disability Onset Among Older Mexicans

Joseph L. Saenz^{1,2} and Rebeca Wong^{1,2}

¹ Department of Preventive Medicine and Community Health, University of Texas Medical Branch, Galveston, TX, USA

² Sealy Center on Aging, University of Texas Medical Branch, Galveston, TX, USA

Abstract

Introduction—Educational disparities research is less common in developing countries. We evaluate whether educational gradients of disability onset exist in Mexico across groups (birth cohort and sex) and whether the association is *unexplained* or indirect via health (health behaviors, chronic conditions, and self-rated health) or economic (income, wealth, and health insurance) pathways.

Method—Data come from the Mexican Health & Aging study. Activities of daily living are reported in 2001, 2003, and 2012 by respondents and spouses aged 50+ ($N = 9,560$). Groups are analyzed using logistic regression to test education–disability onset associations.

Results—Significant education–ADL onset associations were observed across groups, and much of these associations were direct (unexplained by pathways). Indirect effects operated primarily through the health pathway.

Discussion—Those with less education were disadvantaged in terms of disability across birth cohorts and sex. Unexplained effects of education may suggest unobserved mediators or differential returns to resources by educational level.

Keywords

activities of daily living; education; disparity; MHAS

Introduction

Research in the United States and other developed countries has consistently found relationships between socioeconomic status (SES) and health (Braveman, Egerter, & Williams, 2011). Indeed, SES is argued to be a *fundamental cause* of disease (Phelan, Link, Diez-Roux, Kawachi, & Levin, 2004). Lamentably, research on the SES–health relationship

Reprints and permissions: sagepub.com/journalsPermissions.nav

Corresponding Author: Joseph L. Saenz, Preventive Medicine and Community Health, University of Texas Medical Branch, 301 University Blvd., Galveston, TX 77555, USA. jlsaenz@utmb.edu.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

has not been as common in developing countries, most likely due to a lack of data to support analyses in many developing countries. Research that has focused on these environments has found conflicting results with not all developing countries exhibiting SES–health gradients (Smith & Goldman, 2007). The necessity of research on SES–health relationships in developing countries is clear for several reasons. First, many developing countries are experiencing rapid aging (Shrestha, 2000) with scarce or lacking institutional support for the elderly (Wong & Palloni, 2009). The sheer numbers of older adults will represent a great challenge as more developing countries will grapple with the need to provide health care and old-age financial support. Additionally, current elderly populations in many developing countries have survived periods with higher burdens of infectious disease while chronic conditions are becoming more important causes of mortality (Shrestha, 2000). Older populations in developed countries may have faced higher burdens of infectious disease than older populations in developing countries. There are also important differences in SES–health relationships in countries at different levels of development (Riosmena & Dennis, 2012). Finally, developing countries may differ substantially from developed countries in terms of relative SES and education (Glewwe, Kremer, & Welch, 2006). For these reasons, developing countries must be researched from an independent lens. That is, SES–health relationships cannot be generalized from developed to developing societies or even across developing nations, as individual countries present unique political, cultural, and economic contexts. Understanding socioeconomic disparities, lifestyle risk factors throughout the life course and disability processes in developing countries that are experiencing rapid aging is a vital step toward improving population health in these contexts. We evaluate whether educational gradients in disability onset exist across birth cohorts and sex in Mexico and analyze the pathways through which education impacts disability onset.

Literature Review

Research that has examined the SES–health relationship in developing countries has found inconsistent results. We begin by presenting three cases: Taiwan, China, and Costa Rica. These countries are similar to other developing countries in that they are all experiencing rapid population aging. Analyses of mortality using national death registries in Taiwan have demonstrated educational gradients in mortality which are somewhat explained by health indicators (Zimmer, Martin, & Lin, 2005). Additionally, researchers using data from the Survey of Health and Living Conditions of the Aged have found educational gradients in mortality in Wuhan, China, as well and that this association was direct (*operating independently of mediating variables*) and indirect (*operating through mediating variables*; Liang et al., 2000). From Latin America, however, researchers using data from the Costa Rican Study of Longevity and Healthy Aging have found results that are inconsistent with developed nations. While lower education was associated with lower self-rated health, this disadvantage did not carry over to mortality. Additionally, higher rates of cardiovascular risk factors (hypertension and obesity) were observed for persons of higher SES in Costa Rica (Rosero-Bixby & Dow, 2009). It should be noted that Taiwan (Chiang, 1997) and Costa Rica (Pan American Health Organization, 2002) have both implemented universal health care systems, and China initiated a health care reform to provide universal health care by 2020

(Yip et al., 2012). However, educational gradients were observed for mortality in Taiwan and self-rated health in Costa Rica, despite universal health care.

Results from these diverse studies may inform research in other countries, but researchers must be careful not to generalize these findings outside the country from which the samples were drawn. In Mexico, lower education has been found to be associated with worse self-rated health and physical functioning (Smith & Goldman, 2007), more depressive symptoms (Torres & Wong, 2013), and worse cognition (Mejia-Arango & Gutierrez, 2011), while others have found little differences by education in the treatment or awareness of diabetes and hypertension (Beltrán-Sánchez, Drumond-Andrade, & Riosmena, 2015).

Disability Onset and the Mexican Context

Although much research has focused on SES and health, one major concern of these analyses is the operationalization of SES which is often measured through facets including education, occupation, income, and wealth. While this practice is common, these facets of SES should not be treated as interchangeable constructs. Research has found differences in how individual facets of SES are related to stages of disease. For example, multiple studies have found education to predict the onset of functional limitations, while income predicts the progression of functional limitation in the United States (Herd, Goesling, & House, 2007; Zimmer & House, 2003). This same framework has been applied to other developed countries including the United Kingdom (Grundy & Glaser, 2000). We aim to test the merit of this framework in the unique case of Mexico, a developing country experiencing large demographic changes.

Mexico presents an interesting case, as substantial demographic changes have taken place over the previous century, including rising noncommunicable disease mortality (Rivera et al., 2002), rapid population aging (Zúñiga & Vega, 2004), urbanization (Garza, 1999) as well as increases in education across sex and rural/urban areas (Wong & Palloni, 2009). While Mexico is similar to other developing countries in these ways, the unique political, social, historical, and cultural context of Mexico and other developing countries prevent generalization of results across countries. Additionally, given demographic changes in Mexico, researchers must study birth cohorts separately, as different birth cohorts have aged in distinct contexts and endured disparate living conditions. Therefore, we cannot assume that relationships will be constant across subsequent birth cohorts. Also, women in Mexico have had relatively low participation in the formal labor sector compared to other countries (Jaumotte, 2003) such that older women in Mexico may not see the same economic benefits to their education that men do. Additionally, Mexico has a history of strong gender roles with much social and economic power in the hands of males (Stern, 1997). Such a history may suggest that the social and economic experiences of women may be different from that of men. For this reason, we choose to separate our analyses by birth cohort and sex.

Theoretical Framework and Aims

While much research has examined education–health gradients, other research aims to delineate the pathways through which individuals become disabled. We consider two major pathways. The *first* is through health pathways (health behaviors, self-rated health, and

chronic conditions). Through the disablement process (Verbrugge & Jette, 1994), lower education may impact disability onset through an increased risk of certain pathologies such as heart conditions and diabetes as a result of poorer health behaviors and lacking health knowledge (Braveman et al., 2011). The *second* is through economic pathways (Duncan, Daly, McDonough, & Williams, 2002; Pollack et al., 2007) including income, wealth, and health insurance, which may influence the onset and progression of disability. The pathway is then: Low education may predict low income, which restricts one's access to favorable residence and health care. Additionally, those with higher income may be able to afford treatment for chronic conditions and manage diseases more effectively to prevent complications. Finally, wealth may provide people with a resource to draw from in the case of a health problem such as a stroke and may give individuals greater ability to shift careers if they face physically demanding jobs that increase disability risk. We anticipate that economic mechanisms will influence health even after accounting for health variables because income and wealth will impact how one is able to counteract health problems (Zimmer & House, 2003).

The study of education and disability onset in late life requires the use of a life-course framework, which acknowledges the patterning of events throughout the life course. We frame our theory through a chain-of-risk model (Kuh & Ben-Shlomo, 2004) and argue that education can predict late life disability onset directly and indirectly through (a) health behaviors, self-rated health, and chronic conditions and (b) income, wealth, and health insurance. The aims of this analysis are (1) to determine whether educational gradients in disability onset are present across birth cohorts and sex among older Mexicans and (2) to determine to what extent the education–disability onset association is mediated by health behaviors, self-rated health, and chronic conditions or income, wealth, and health insurance across birth cohorts and sex among older Mexicans.

Research Design

Data come from Waves 1–3 of the Mexican Health & Aging Study (MHAS; MHAS, 2001). The MHAS is a large, longitudinal, household-based sample of Mexican adults (aged 50+ in 2001) and spouses. Interviews were conducted in 2001, 2003, and 2012. The study was approved by the Institutional Review Boards or Ethics Committees of the University of Texas Medical Branch in the United States, the Instituto Nacional de Estadística y Geografía (INEGI), and the Instituto Nacional de Salud Pública (INSP) in Mexico. The baseline sample size was 15,186. Because this analysis is focused on late-life disability onset, the analytic sample includes respondents and spouses (age 50+ at baseline) who were free of activities of daily living (ADLs) disability in 2001 and were interviewed at least once after baseline. Respondents with missing covariates were also eliminated from the analysis, making a final sample size of 9,560. As the analytic sample is slightly younger (1 year difference in mean ages), slightly more female (1.6% difference in percent female), and reports slightly better self-rated health than the full sample, we tested a two-step Heckman probit model with sample selection (Heckman, 1979) and obtained similar results. For this reason we present the results of the standard logistic regressions.

The sample is divided into two birth cohorts by splitting the sample at the median birth year to create similar sample sizes across birth cohorts. Birth cohorts are 50–59 or 60+ at baseline. This approach is also supported by significant cohort–education interactions. While we split our sample into birth cohorts as respondents aged in different contexts, we cannot distinguish age versus cohort effects. Parameter estimates across cohorts may differ due to differences in the relationships between variables across age-groups or cohorts. However, we feel that this approach is preferred as large changes in the previous century in Mexico prevent the assumption that results will be similar across birth cohorts.

We will include demographic, health, and economic covariates in our analyses. Demographic covariates will be used as control variables, while health and economic variables will be used to test health and economic pathways. Demographic variables come from baseline and include age, sex, marital status, education, and whether the respondent lived in a rural or urban area. Marital status is categorized as married, widowed, or other (divorced, separated, or never married). Education is categorized according to years of formal education as no education: 0 years, incomplete elementary education: 1–5 years, elementary education: 6 years, and beyond elementary education: 7+ years. Rural/urban is operationalized as whether the respondent lived in a more (community size larger than 100,000 persons) or less urban area (less than 100,000 persons).

Health behavior covariates include smoking and binge drinking. Smoking is categorized as never/former/current smoker. Binge drinking is based on self-reported binge drinking in the previous 3 months. Chronic conditions assessed in the survey include self-reported hypertension, cancer, strokes, heart attacks, diabetes, and pulmonary conditions. As few respondents report certain chronic conditions, a count of chronic conditions is used in the analyses. Self-rated health is categorized as poor, fair, good, and very good/excellent. Disability is captured through self-reported limitations with ADLs (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963). Respondents are asked in each wave whether they have trouble dressing, bathing, eating, getting out of bed, and using the toilet. Respondents who report any ADL disability in 2003 or 2012 were considered to have disability onset, as the analytic sample is free of ADL disability at baseline (2001). ADL categorizations are based on those used by previous MHAS researchers (Díaz-Venegas, 2013).

Income from various sources is assessed at the individual level to obtain estimates of total individual income. Income is separated into tertiles with the highest income tertile used as the reference group in regressions. Missing income data were imputed by the MHAS (Wong & Espinoza, 2004). Wealth is assessed at the household level and is measured as the sum of the reported value of businesses, real estate, money in accounts and stocks, transportation, and any other assets and then separated into tertiles with the highest tertile used as the reference group. Additionally, we include health insurance which is operationalized as whether the respondent had health insurance from any source at baseline. However, estimates for the impact of health insurance on disability onset may be biased as health insurance is not determined exogenously. Respondents may obtain health insurance because of health problems creating a biased estimate of the effect of health insurance. Mexico also passed a voluntary health insurance program, Seguro Popular, in 2003 which resulted in large gains in health care coverage after 2003 (Bosch, Cobacho, & Pagés, 2012). We use

health insurance status at baseline (2001) for two reasons: (1) Health insurance may take time to impact health and a respondent's health coverage in 2001 may have lasted long before the study began and impacted disability risk prior to the study and (2) Health insurance status in 2001 allows us to demonstrate that health insurance status preceded the disability onset. As participants may enroll in Seguro Popular throughout follow-up, we cannot determine whether Seguro Popular enrollment preceded the disability onset.

The sample is separated by sex and birth cohort to form four groups. Each group is analyzed separately using logistic regression. Each model is labeled with a number and a letter where the number indicates the group (1–4) and the letter indicates the covariates (a–d). Models 1–4a show the *raw effect* of education by including education and other variables that are not assumed to be mediators between education and disability onset (age, rural/urban, and marital status). Models 1–4b illustrate whether the education–disability onset association is mediated through the *health pathway* by adding the covariates in this pathway (smoking behaviors, binge drinking, chronic condition count, and self-rated health) to Models 1–4a. Models 1–4c demonstrate whether the education–disability onset association is mediated through the *economic pathway* by adding income and wealth to Models 1–4a. Models 1–4d add variables from the *health and economic pathways* to Model 1–4a because income and wealth may correlate with health. Health insurance is included in Models 1–4d with health covariates to account for some of the health-related self-selection into health insurance.

Formal tests of mediation by the health and economic factors are performed using the *Karlson, Holm and Breen* (KHB) method which decomposes the total effect of an independent variable (education) on a dependent variable (disability onset) into direct (unexplained by mediators) and indirect (through mediators) components and allows the user to determine the percentage of the indirect effect that is explained by individual variables in multiple mediator models. The KHB method has been used *recently* to assess mediation (Torres & Wong, 2013) and has been explained in greater detail elsewhere (Kohler, Karlson, & Holm, 2011). All models are fit using STATA SE 13 and include a variable indicating whether disability onset or censoring occurred in 2003 or 2012 to account for differential length of follow-up, as disability onset could occur in 2003 or 2012, and some respondents are reinterviewed in 2003 but not 2012 due to loss to follow-up and mortality.

Results

Descriptive Results

Descriptive results are shown in Table 1. Of the 9,560 respondents in the analytic sample, 1,995 (20.9%) experienced ADL onset over follow-up. Sufficient sample size is seen in each group with 2,117 in the younger male group, 2,666 in the younger female group, 2,213 in the older male group, and 2,564 in the older female group. ADL onset was more common among females (23.8% vs. 17.3% in males) and the older cohort (26.1% vs. 15.6% in the younger cohort). Educational attainment was higher in the younger birth cohort than the older birth cohort. Additionally, educational attainment was higher among men than women in both cohorts. Figure 1 shows the unadjusted percentage reporting ADL onset over follow-up according to level of education by birth cohort/sex group. For each birth cohort/sex

group, the percentage reporting ADL onset over follow-up is lower for those with higher levels of education. While educational gradients in ADL onset are seen for all groups in Figure 1, these results are unadjusted and do not take into account mediating or confounding variables.

Regression Analyses

Regression analyses for the younger cohort are shown in Table 2. We first focus on younger males. In Model 1a, only education and nonmediating variables (age, rural/urban, and marital status) are included. A statistically significant educational gradient in ADL onset was observed with higher odds of ADL onset among those with lower levels of educational attainment. The odds ratio comparing those with no education to those with 7+ years of education was 3.06 ($p < .001$). A significant odds ratio was also observed comparing those with 1–5 years to those with 7+ years of education. In Model 1b, we added health variables (chronic condition count, smoking behavior, binge drinking, and self-rated health) to determine whether the education odds ratios obtained in Model 1a decrease. Such a decrease would suggest that the health pathway may be mediating the education–ADL onset association. Having more chronic conditions as well as reporting poor self-rated health were associated with higher odds of disability onset. The inclusion of the health pathway reduced all education odds ratios suggesting that the education–disability onset association may be mediated by the health pathway. In Model 1c, we swap the health variables for income and wealth to determine whether income and wealth mediate the education–ADL onset association. Although neither income nor wealth were significantly associated with ADL onset on their own, their combined effects reduced education odds ratios suggesting that income and wealth may partially mediate the education–ADL onset association. After including all covariates in Model 1d, the education odds ratios were lower than the model with only the health or economic pathway, suggesting that both pathways may mediate the education–disability onset association. Health insurance was not a significant predictor of disability onset. In further analyses (results not shown), we found that hypertension and diabetes were driving the association between chronic condition count and disability onset.

Results for younger females are similar to those observed among younger males. A significant educational gradient in ADL onset was observed in Model 2a with an odds ratio of 2.40 ($p < .001$) comparing those with no education to those with 7+ years of education. Additionally, those with 1–5 or 6 years of education had significantly higher odds of ADL onset over follow-up. The introduction of the health pathway in Model 2b or the economic pathway in Model 2c reduced the education odds ratios, and the inclusion of both pathways in Model 2d reduced the education odds ratios more substantially, suggesting that both pathways may mediate the education–disability onset association. Reporting more chronic conditions, poor self-rated health, and lower income were associated with disability onset among younger females. Health insurance was not a significant predictor of disability onset. In further analyses (results not shown), we found that hypertension was driving the association between chronic condition count and disability onset.

Regression analyses for the older cohort are shown in Table 3. For older males, a significant educational gradient in disability onset was observed in Model 3a, with higher odds of ADL

onset among the lower educated. The odds ratios comparing those with no education to those with 7+ years of education was 1.47 ($p < .05$). Those with 1–5 years of education also had significantly higher odds of ADL onset compared to those with 7+ years of education. The inclusion of health variables in Model 3b or the inclusion of income and wealth in Model 3c both reduce the education odds ratios to below levels of statistical significance, suggesting that both pathways mediate the education–disability onset association. While being in the middle-income tertile compared to the high-income tertile was associated with disability onset in Model 3c, statistical significance was not reached in the full model (Model 3d). In the full model, having more chronic conditions and lower self-rated health were associated with higher odds of disability onset. Health insurance was not a significant predictor of disability onset. In further analyses (results not shown), we found that diabetes was driving the association between chronic condition count and disability onset.

For the older female group, a significant educational gradient was observed in Model 4a. Respondents with 0 years, 1–5 years, or 6 years had significantly higher odds of ADL onset compared to those with 7+ years of education. The odds ratio for having no education was 2.10 ($p < .001$). Similar to the other groups, the inclusion of the health pathway in Model 4b or the economic pathway in Model 4c reduced the education odds ratios, while the combined effect of the pathways in the full model (Model 4d) resulted in a more substantial reduction in the education odds ratios than the reduction observed when including each pathway independently. In the full model, having more chronic conditions, having poor self-rated health, and having lower income were associated with higher odds of disability onset. Health insurance was not a significant predictor of disability onset. In further analyses (results not shown), we found that diabetes was driving the association between chronic condition count and disability onset.

Sensitivity analyses were performed by testing models predicting disability onset in 2003 versus 2012, but results were similar to those predicting disability onset at either time point while including a covariate indicating in which wave disability onset occurred. For this reason, we presented the results of the latter. Also, ADLs may be a relatively high disability threshold. Thus, we performed sensitivity analyses using Nagi items (trouble stooping, extending one's arms, pushing, lifting or carrying large objects, and picking up a coin; Nagi, 1976) to determine whether the education–functional limitation onset relationship holds. We found similar results (not shown) with the lower disability threshold.

Mediation Analyses

Mediation analyses are done separately by birth cohort/sex group. For each group, a logistic regression model predicting ADL onset using years of education and all proposed mediators (health behaviors, chronic conditions, self-rated health, income, wealth, and health insurance) was used. We use years of education instead of education categories to facilitate interpretations of the decomposition results. Only the mediators that reduce the education–ADL onset association are treated as mediators in final models (shown in Table 4). The upper panel shows that for younger males, the *total* effect of education is -0.083 , suggesting a decrease in odds of disability onset with increasing years of education. However, this total effect can be broken into a direct/unexplained (-0.056) and an indirect (-0.027) effect that

sum to the total effect. The “direct” effect is the portion of the association between an independent and a dependent variable that is not explained by mediating variables. In other words, the portion of this association remains in fully adjusted models. The “indirect” effect is the portion of this association that is explained by mediating variables. For younger males, the percentage of the total effect that is indirect conveys that only 32.7% of the education–ADL onset association is operating through either health or economic pathways. To determine which pathway is playing a greater role in mediating the education–ADL onset association, we decompose the *indirect* effect to assess the contribution of each individual pathway. The lower panel shows that for younger males, of the indirect effect, 45.4% is explained by the economic pathway while 54.6% is explained by the health pathway. For all groups but older males, the majority of the education–disability onset association is direct (unexplained). For older males, approximately half of the education–disability onset is indirect. For all groups, over half of the indirect effect (between 55% and 64%) operated through the health pathway.

Discussion

The results of this analysis are consistent with results obtained in developed countries showing educational gradients in disability onset (Grundy & Glaser, 2000; Herd et al., 2007; Zimmer & House, 2003). In reference to our first aim, we find little difference in the education–ADL onset association across four groups defined by birth cohort and sex. Respondents with lower education had higher odds of ADL onset in all groups. The only unique case was that of older males where educational gradients lost statistical significance with the inclusion of proposed mediators. Ubiquitous gradients suggest that more work is needed to reduce educational disparities in Mexico. For our second aim, we find important indirect effects of education on disability onset (a significant portion of the education–disability onset association operated through health and economic pathways) in all groups. Across sex and birth cohort, more than half of the indirect effect of education was operating through the health pathway. Still, there was a significant portion of the education–disability onset association that was left unexplained across groups. The only group in which the education–disability onset association was not significant in fully adjusted models was for older males. Lower education may impact disability onset through chronic conditions. Income and wealth may also operate as mediators because those with higher education may have higher levels of income and wealth which may provide them with better health care, treatment options, and rehabilitation.

An additional concern is the large portion of the education–ADL onset association that was left unexplained. This might be caused by omitted variables that would operate as additional mediators. For example, treatment compliance may be an unobserved mediator. Respondents with low education may have health insurance and resources similar to a respondent with high education, but respondent with higher education may be able to utilize these resources more effectively to reap greater returns (Leigh, 1983). This can be evidenced through better compliance with treatments (Goldman & Smith, 2002) and management of chronic conditions among those with higher levels of education (Goldman & Lakdawalla, 2001). Indeed, these results agree with the arguments made in fundamental cause theory (Link &

Phelan, 1995) and the idea that education supports cognitive resources that may benefit individuals in terms of health (Lleras-Muney, 2005).

There are limitations worth mentioning. First, as suggested earlier, there may be omitted mediators that may inflate the unexplained effect of education. Although concerns for omitted variables are always present in secondary data and we included a wide variety of covariates, future researchers are urged to study other possible mediators. Second, although we include a variable for the number of waves the respondent contributed to the study to account for attrition and timing of disability onset, future studies may be strengthened by collecting estimates of when disability onset occurred between waves to capture disability onset more precisely and allow for the use of time-to-event analyses. Finally, disability is a function of both biological deterioration and one's environment. That is, inability to climb stairs may be disabling for those who cannot avoid stairs, and this may be influenced by economic factors. Notwithstanding these limitations, this analysis comes with several strengths. First, we were able to analyze a nationally representative sample of older Mexican adults with a large enough sample size to examine differences by birth cohort and sex. Second, the study has 11 years of follow-up providing a great opportunity to detect ADL onset. Third, the MHAS has had remarkably low attrition with a response rate of 88% from 2003 to 2012 (Estudio Nacional de Salud y Envejecimiento en México, 2013). Finally, the MHAS has a large variety of detailed information on respondents which allows us to examine disability using many variables and a multidimensional approach by analyzing health and economic pathways.

Conclusion

Lower educational attainment is associated with higher odds of disability onset in old age regardless of birth cohort and sex among older Mexicans. While significant indirect effects were observed, most birth/cohort sex groups exhibited substantial unexplained effects of education on disability onset. The majority of the indirect effect of education on disability onset was through health mechanisms rather than economic mechanisms in all birth cohort/sex groups. While great strides have already been made in Mexico which may reduce socioeconomic health disparities including the Progresas/Oportunidades and Seguro Popular programs, public policy should continue to focus on improving educational opportunities, reducing resource inequality, and facilitating effective use of health care, particularly among groups with low education. Future research on educational gradients in disability onset in Mexico should aim to delineate other pathways from education to disability onset and explain more in depth the unexplained effect of education.

Acknowledgments

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was conducted with the support of the Sealy Center on Aging at the University of Texas Medical Branch, and by the Health of Older Minorities Award (T32AG00270) from the National Institutes of Health/National Institute on Aging. The MHAS is partly sponsored by the National Institutes of Health/National Institute on Aging (grant number NIH R01AG018016). Data files and documentation are public use and available at www.MHASweb.org.

Biography

Joseph L. Saenz is a PhD student in Preventive Medicine and Community Health at the University of Texas Medical Branch in Galveston. His research focuses on socioeconomic disparities as well as how early life risk factors impact disability and mortality among older Mexicans and Mexican-Americans.

Rebeca Wong is a Professor in Preventive Medicine and Community Health and senior fellow of the Sealy Center on Aging at the University of Texas Medical Branch in Galveston. Her research focuses on the economics and demography of health and aging in Latin America with emphasis in Mexico and U.S. immigrants.

References

- Beltrán-Sánchez H, Drumond-Andrade FC, Riosmena F. Contribution of socioeconomic factors and health care access to the awareness and treatment of diabetes and hypertension among older Mexican adults. *Salud Pública de México*. 2015; 57 Retrieved from <http://www.medigraphic.com/pdfs/salpubmex/sal-2015/sals151c.pdf>.
- Bosch, M.; Cobacho, MB.; Pagés, C. Taking stock of eight years of implementation of Seguro popular in Mexico. Inter-American Development Bank; Washington, DC: 2012.
- Braveman P, Egerter S, Williams DR. The social determinants of health: Coming of age. *Annual Review of Public Health*. 2011; 32:381–398. Retrieved from <http://doi.org/10.1146/annurev-publhealth-031210-101218>.
- Chiang T. Taiwan's 1995 health care reform. *Health Policy*. 1997; 39:225–239. Retrieved from [http://doi.org/10.1016/S0168-8510\(96\)00877-9](http://doi.org/10.1016/S0168-8510(96)00877-9). [PubMed: 10165463]
- Díaz-Venegas, C. ADL coding. 2013. Retrieved from <http://www.mhasweb.org/DiscussionForum/File%20Upload/Documents/ADL%20coding.txt>
- Duncan GJ, Daly MC, McDonough P, Williams DR. Optimal indicators of socioeconomic status for health research. *American Journal of Public Health*. 2002; 92:1151–1157. Retrieved from <http://doi.org/10.2105/AJPH.92.7.1151>. [PubMed: 12084700]
- Estudio Nacional de Salud y Envejecimiento en México. ENA SEM Descripción de los Archivos de Datos, Versión 1, Septiembre 2013. Sep. 2013 Retrieved from http://mhasweb.org/Resources/DOCUMENTS/2012/Descripcion_Bases_de_Datos_2012.pdf
- Garza G. Global economy, metropolitan dynamics and urban policies in Mexico. *Cities*. 1999; 16:149–170. Retrieved from [http://doi.org/10.1016/S0264-2751\(99\)00013-X](http://doi.org/10.1016/S0264-2751(99)00013-X).
- Glewwe, P.; Kremer, M.; Welch, EHAF. Schools, teachers, and education outcomes in developing countries.. In: Hanushek, E.; Welch, F., editors. *Handbook of the economics of education*. Vol. 2. Elsevier; 2006. p. 945-1017. Retrieved from <http://www.sciencedirect.com/science/article/pii/S1574069206020162>
- Goldman, D.; Lakdawalla, D. Understanding health disparities across education groups (Working Paper No. 8328). National Bureau of Economic Research; Cambridge, Massachusetts: 2001. Retrieved from <http://www.nber.org/papers/w8328>
- Goldman D, Smith JP. Can patient self-management help explain the SES health gradient? *Proceedings of the National Academy of Sciences*. 2002; 99:10929–10934. Retrieved from <http://doi.org/10.1073/pnas.162086599>.
- Grundy E, Glaser K. Socio-demographic differences in the onset and progression of disability in early old age: A longitudinal study. *Age and Ageing*. 2000; 29:149–157. Retrieved from <http://doi.org/10.1093/ageing/29.2.149>. [PubMed: 10791450]
- Heckman JJ. Sample selection bias as a specification error. *Econometrica*. 1979; 47:153–161. Retrieved from <http://doi.org/10.2307/1912352>.
- Herd P, Goesling B, House JS. Socioeconomic position and health: The differential effects of education versus Income on the onset versus progression of health problems. *Journal of Health and*

- Social Behavior. 2007; 48:223–238. Retrieved from <http://doi.org/10.1177/002214650704800302>. [PubMed: 17982865]
- Jaumotte, F. Female labour force participation: Past trends and main determinants in OECD countries (OECD Economics Department Working Paper No. 376). OECD Publishing; Frsnce, Paris: 2003. Retrieved from <http://econpapers.repec.org/paper/oecococaaa/376-en.htm>
- Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged: The index of adl: A standardized measure of biological and psychosocial function. JAMA. 1963; 185:914–919. Retrieved from <http://doi.org/10.1001/jama.1963.03060120024016>. [PubMed: 14044222]
- Kohler U, Karlson KB, Holm A. Comparing coefficients of nested nonlinear probability models. Stata Journal. 2011; 11:420–438.
- Kuh, D.; Ben-Shlomo, Y. A life course approach to chronic disease epidemiology. 2. Oxford University Press; Oxford: 2004. p. 473
- Leigh JP. Direct and indirect effects of education on health. Social Science & Medicine. 1983; 17:227–234. [PubMed: 6844955]
- Liang J, McCarthy JF, Jain A, Krause N, Bennett JM, Gu S. Socioeconomic gradient in old age mortality in Wuhan, China. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2000; 55:S222–S233. Retrieved from <http://doi.org/10.1093/geronb/55.4.S222>.
- Link BG, Phelan J. Social conditions as fundamental causes of disease. Journal of Health and Social Behavior. 1995; 35:80–94. Retrieved from <http://doi.org/10.2307/2626958>. [PubMed: 7560851]
- Lleras-Muney A. The relationship between education and adult mortality in the United States. The Review of Economic Studies. 2005; 72:189–221. Retrieved from <http://doi.org/10.1111/0034-6527.00329>.
- Mejia-Arango S, Gutierrez LM. Prevalence and incidence rates of dementia and cognitive impairment no dementia in the Mexican population data from the Mexican health and aging study. Journal of Aging and Health. 2011; 23:1050–1074. Retrieved from <http://doi.org/10.1177/0898264311421199>. [PubMed: 21948770]
- Mexican Health & Aging Study. [December 5, 2014] MHAS Mexican Health and Aging Study, (2001, 2003, 2012). Data files and documentation (public use): Mexican Health and Aging Study. 2001. from www.MHASweb.org
- Nagi SZ. An epidemiology of disability among adults in the United States. The Milbank Memorial Fund Quarterly. Health and Society. 1976; 54:439–467. Retrieved from <http://doi.org/10.2307/3349677>.
- Pan American Health Organization. Profile of the health services system of Costa Rica (Unpublished report). Pan American Health Organization (PAHO) Division of Health Systems and Services Development; Washington, DC: 2002.
- Phelan JC, Link BG, Diez-Roux A, Kawachi I, Levin B. “Fundamental causes” of social inequalities in mortality: A test of the theory. Journal of Health and Social Behavior. 2004; 45:265–285. Retrieved from <http://doi.org/10.1177/002214650404500303>. [PubMed: 15595507]
- Pollack CE, Chideya S, Cubbin C, Williams B, Dekker M, Braveman P. Should health studies measure wealth?: A systematic review. American Journal of Preventive Medicine. 2007; 33:250–264. Retrieved from <http://doi.org/10.1016/j.amepre.2007.04.033>. [PubMed: 17826585]
- Riosmena, F.; Dennis, JA. A tale of three paradoxes: The weak socioeconomic gradients in health among hispanic immigrants and their relation to the hispanic health paradox and negative acculturation.. In: Angel, JL.; Torres-Gil, F.; Markides, K., editors. Aging, health, and longevity in the Mexican-origin population. Springer; New York, NY: 2012. p. 95-110. Retrieved from http://link.springer.com/chapter/10.1007/978-1-4614-1867-2_8
- Rivera JA, Barquera S, Campirano F, Campos I, Safdie M, Tovar V. Epidemiological and nutritional transition in Mexico: Rapid increase of non-communicable chronic diseases and obesity. Public Health Nutrition. 2002; 5:113–122. Retrieved from <http://doi.org/10.1079/PHN2001282>. [PubMed: 12027273]
- Rosero-Bixby L, Dow WH. Surprising SES gradients in mortality, health, and biomarkers in a Latin American population of adults. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2009; 64B:105–117. Retrieved from <http://doi.org/10.1093/geronb/gbn004>.

- Shrestha LB. Population aging in developing countries. *Health Affairs*. 2000; 19:204–212. Retrieved from <http://doi.org/10.1377/hlthaff.19.3.204>. [PubMed: 10812800]
- Smith KV, Goldman N. Socioeconomic differences in health among older adults in Mexico. *Social Science & Medicine*. 2007; 65:1372–1385. Retrieved from <http://doi.org/10.1016/j.socscimed.2007.05.023>. [PubMed: 17618717]
- Stern, SJ. *The secret history of gender: Women, men, and power in late colonial Mexico*. University of North Carolina Press; Chapel Hill: 1997.
- Torres JM, Wong R. Childhood poverty and depressive symptoms for older adults in Mexico: A life-course analysis. *Journal of Cross-Cultural Gerontology*. 2013; 28:317–337. Retrieved from <http://doi.org/10.1007/s10823-013-9198-1>. [PubMed: 23783887]
- Verbrugge LM, Jette AM. The disablement process. *Social Science & Medicine*. 1994; 38:1–14. Retrieved from [http://doi.org/10.1016/0277-9536\(94\)90294-1](http://doi.org/10.1016/0277-9536(94)90294-1). [PubMed: 8146699]
- Wong, R.; Espinoza, M. Imputation of non-response on economic variables in the Mexican health and aging study (MHAS/ENASEM) 2001. 2004. Retrieved from http://mhasweb.org/Resources/DOCUMENTS/2001/Imputation_of_Non-Response_on_Economic_Variables_in_the_MHAS-ENASEM_2001.pdf
- Wong, R.; Palloni, A. Aging in Mexico and Latin America.. In: Uhlenberg, P., editor. *International handbook of population aging*. Springer; Dordrecht, the Netherlands: 2009. p. 231-252. Retrieved from http://link.springer.com/chapter/10.1007/978-1-4020-8356-3_11
- Yip WC-M, Hsiao WC, Chen W, Hu S, Ma J, Maynard A. Early appraisal of China's huge and complex health-care reforms. *The Lancet*. 2012; 379:833–842. Retrieved from [http://doi.org/10.1016/S0140-6736\(11\)61880-1](http://doi.org/10.1016/S0140-6736(11)61880-1).
- Zimmer Z, House JS. Education, income, and functional limitation transitions among American adults: Contrasting onset and progression. *International Journal of Epidemiology*. 2003; 32:1089–1097. Retrieved from <http://doi.org/10.1093/ije/dyg254>. [PubMed: 14681281]
- Zimmer Z, Martin LG, Lin H-S. Determinants of old-age mortality in Taiwan. *Social Science & Medicine*. 2005; 60:457–470. Retrieved from <http://doi.org/10.1016/j.socscimed.2004.06.006>. [PubMed: 15550295]
- Zúñiga, E.; Vega, D. *Envejecimiento de la Población de México Reto del siglo XXI*. 2004. Retrieved from <http://www.conapo.gob.mx/publicaciones/enveje2005/enveje00.pdf>

Figure 1.

Percentage of respondents with activities of daily living (ADL) onset between 2001 and 2012 by sex, birth cohort, and level of education. Adapted from own calculations using data from the Mexican Health and Aging Study (MHAS), $N = 9,560$.

Note. Younger birth cohort = individuals aged 50–59 at the 2001 baseline. Older birth cohort = individuals aged 60+ at the 2001 baseline.

Table 1

Distribution of Baseline Variables and Activities of Daily Living (ADL) Onset Among Older Mexicans by Birth Cohort^a and Sex.

	Younger Males (<i>n</i> = 2,117)	Younger Females (<i>n</i> = 2,666)	Older Males (<i>n</i> = 2,213)	Older Females (<i>n</i> = 2,564)
Onset of ADL				
Onset of ADL %	13.3	17.4	21.2	30.4
Level of education				
0 years %	12.7	18.6	26.8	33.1
1–5 years %	30.2	34.4	39.9	36.2
6 years %	23.4	20.3	17.0	15.5
7+ years %	33.6	26.7	16.3	15.3
Age				
Mean (SD)	54.2 (2.8)	54.2 (2.8)	68.7 (6.9)	68.1 (6.7)
Area of residence				
More Urban %	67.6	69.3	62.0	66.3
Marital status				
Widowed %	2.9	12.1	12.6	37.1
Other %	8.0	17.8	7.9	14.4
Married %	89.0	70.1	79.6	48.6
Chronic condition count				
Mean (SD)	0.44 (0.7)	0.68 (0.8)	0.58 (0.8)	0.77 (0.8)
Smoking behavior				
Former smoker %	34.3	14.8	45.3	16.7
Smoke now %	30.9	10.6	22.6	7.9
Never smoker %	34.7	74.6	32.2	75.4
Binge drinking				
Binge drinking %	21.7	1.7	12.0	1.1
Self-rated health				
Poor	7.4	12.1	14.6	17.8
Fair	41.0	51.5	45.8	52.2
Good	40.9	30.9	33.6	26.1
Very good	10.7	5.5	6.0	3.9
Income				
Low tertile %	27.5	33.8	30.6	37.5
Mid tertile %	28.5	31.9	38.0	37.2
High tertile %	44.0	34.4	31.5	25.4
Wealth				
Low tertile %	29.1	30.3	32.8	38.7
Mid tertile %	34.7	34.6	34.8	32.6
High tertile %	36.2	35.1	32.4	28.7
Health insurance (2001)				

	Younger Males (<i>n</i> = 2,117)	Younger Females (<i>n</i> = 2,666)	Older Males (<i>n</i> = 2,213)	Older Females (<i>n</i> = 2,564)
Any health insurance	60.3	63.8	62.4	64.8

Note. Adapted from own calculations using data from the Mexican Health and Aging Study (MHAS), *N* = 9,560.

^aYounger birth cohort = individuals aged 50–59 at the 2001 baseline. Older birth cohort = individuals aged 60+ at the 2001 baseline.

Logistic Regressions for Onset of Limitations in Activities of Daily Living (ADL) Between 2001 and 2012 in the Younger Cohort (Aged 50–59 in 2001) by Sex.

	Younger Males (<i>n</i> = 2,117)						Younger Females (<i>n</i> = 2,666)					
	Model 1a		Model 1b		Model 1c		Model 2a		Model 2b		Model 2c	
	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE
Level of education												
0 years (Ref: 7+ years)	3.06	*** (.65)	2.71	*** (.59)	2.59	*** (.58)	2.40	*** (.41)	2.00	*** (.34)	2.05	*** (.36)
1–5 Years (Ref: 7+ years)	1.99	*** (.36)	1.68	** (.31)	1.77	** (.33)	2.02	*** (.31)	1.68	** (.26)	1.79	*** (.28)
6 years (Ref: 7+ years)	1.38	(.27)	1.17	(.24)	1.27	(.26)	1.59	** (.27)	1.40	(.24)	1.42	* (.25)
Demographics												
Age	1.02	(.02)	1.01	(.02)	1.03	(.02)	1.02	(.02)	1.02	(.02)	1.02	(.02)
More urban (Ref: less urban)	0.89	(.13)	0.90	(.13)	0.93	(.13)	0.91	(.10)	0.92	(.11)	0.95	(.11)
Marital status												
Widowed (Ref: married)	0.85	(.33)	0.99	(.39)	0.88	(.35)	0.78	(.13)	0.76	(.13)	0.79	(.14)
Other (Ref: married)	0.62	(.17)	0.68	(.19)	0.59	(.17)	0.96	(.13)	0.97	(.14)	0.94	(.13)
Health behaviors and chronic conditions												
Chronic condition count	1.39	*** (.13)	1.39	*** (.13)	1.40	*** (.13)	1.30	*** (.09)	1.30	*** (.09)	1.29	*** (.09)
Former smoker (Ref: never)	0.84	(.13)	0.84	(.13)	0.83	(.13)	0.88	(.14)	0.88	(.14)	0.88	(.14)
Smoke now (Ref: never)	0.94	(.16)	0.94	(.16)	0.93	(.15)	1.12	(.19)	1.12	(.19)	1.14	(.20)
Binge drinking (Ref: No)	0.88	(.15)	0.88	(.15)	0.89	(.15)	1.67	(.61)	1.67	(.61)	1.70	(.62)
Self-rated health												
Poor (Ref: excellent)	1.92	* (.58)	1.92	* (.58)	1.86	* (.56)	2.15	* (.69)	2.15	* (.69)	2.14	* (.69)
Fair (Ref: excellent)	1.23	(.30)	1.23	(.30)	1.16	(.29)	1.60	(.48)	1.60	(.48)	1.59	(.47)
Good (Ref: excellent)	0.60	* (.15)	0.60	* (.15)	0.57	* (.15)	1.04	(.32)	1.04	(.32)	1.04	(.32)
Income												
Low tertile (Ref: high tertile)			1.21	(.20)	1.16	(.19)			1.41	* (.19)	1.47	** (.21)
Mid tertile (Ref: high tertile)			1.22	(.23)	1.19	(.20)			1.35	* (.19)	1.38	* (.20)
Wealth												

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.

Table 3

Logistic Regressions for Onset of Activities of Daily Living (ADL) Limitations Between 2001 and 2012 in the Older Cohort (Aged 60+ in 2001) by Sex.

	Older Males (<i>n</i> = 2,213)						Older Females (<i>n</i> = 2,564)					
	Model 3a		Model 3b		Model 3c		Model 4a		Model 4b		Model 4c	
	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE
Education												
0 years (Ref: 7+ years)	1.47	*(0.28)	1.29	(0.25)	1.30	(0.25)	2.10	*** (0.32)	1.80	*** (0.28)	1.82	*** (0.29)
1–5 years (Ref: 7+ years)	1.57	*(0.28)	1.41	(0.26)	1.43	*(0.26)	1.81	*** (0.27)	1.55	*** (0.24)	1.61	*** (0.25)
6 years (Ref: 7+ years)	1.45	(0.29)	1.28	(0.26)	1.34	(0.27)	1.47	*(0.25)	1.31	(0.23)	1.35	(0.23)
Demographics												
Age	1.05	*** (0.01)	1.05	*** (0.01)	1.05	*** (0.01)	1.03	*** (0.01)	1.03	*** (0.01)	1.03	*** (0.01)
More urban (Less urban)	0.83	(0.09)	0.86	(0.10)	0.85	(0.10)	0.95	(0.09)	0.97	(0.09)	0.97	(0.09)
Marital status												
Widowed (Ref: married)	1.01	(0.15)	1.04	(0.17)	1.04	(0.17)	0.97	(0.10)	0.98	(0.10)	0.96	(0.10)
Other (Ref: married)	0.73	(0.16)	0.72	(0.16)	0.72	(0.16)	1.00	(0.13)	0.99	(0.14)	0.98	(0.13)
Health behaviors and chronic conditions												
Chronic condition count			1.17	*(0.09)			1.17	*(0.09)	1.22	** (0.07)		
Former smoker (Ref: never)			1.06	(0.13)			1.05	(0.13)	1.01	(0.12)		
Smoke now (Ref: never)			0.87	(0.13)			0.85	(0.13)	1.07	(0.18)		
Binge drinking (Ref: no)			0.75	(0.14)			0.76	(0.14)	0.90	(0.40)		
Self-rated health												
Poor (Ref: excellent)			4.74	*** (1.79)			4.63	*** (1.75)	2.48	** (0.71)		
Fair (Ref: excellent)			3.52	*** (1.27)			3.40	** (1.23)	1.70	(0.47)		
Good (Ref: excellent)			2.68	** (0.97)			2.62	** (0.96)	1.07	(0.30)		
Income												
Low tertile (Ref: high tertile)					1.31	(0.19)					1.32	*(0.16)
Mid tertile (Ref: high tertile)					1.32	*(0.18)					1.42	** (0.17)
Wealth												

	Older Males (<i>n</i> = 2,213)						Older Females (<i>n</i> = 2,564)					
	Model 3a		Model 3b		Model 3c		Model 4a		Model 4b		Model 4c	
	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE	OR	SE
Low tertile (Ref: high tertile)					1.13	(0.16)					1.16	(0.13)
Mid tertile (Ref: high tertile)					1.20	(0.16)					1.07	(0.12)
Health insurance												
Insured (Ref: not insured)											0.97	(0.10)

Note: OR = odds ratio; SE = standard error. All models include the number of waves the respondent was followed up to account for differential length of follow up. Adapted from own calculations using data from the Mexican Health and Aging Study (MHAS).

* $p < .05$.
** $p < .01$.
*** $p < .001$.

Decomposition of the Effect of Education on Onset of Activities of Daily Living (ADL) Limitations From 2001 to 2012 Through Health and Economic Pathways by Birth Cohort^a and Sex.

	Younger Males			Younger Females			Older Males			Older Females		
	β	<i>p</i>	%	β	<i>p</i>	%	β	<i>p</i>	%	β	<i>p</i>	%
Decomposition of total effect of years of education on ADL onset (health and economic pathways)												
Total Effect	-.083	***		-.098	***		-.051	**		-.077	***	
Direct Effect	-.056	**	67.3	-.065	***	67.0	-.025		49.1	-.048	**	63.0
Indirect Effect	-.027	***	32.7	-.032	***	33.0	-.026	***	50.9	-.028	***	37.0
Decomposition of indirect effect by health and economic pathways												
Health Pathway ^b	-.015 ^c		54.6	-.019 ^d		59.7	-.016 ^e		63.7	-.016 ^f		55.5
Economic Pathway ^g	-.012		45.4	-.013		40.3	-.009		36.3	-.013		44.5

Note. $p = p$ value. Adapted from own calculations using data from the Mexican Health and Aging Study (MHAS), $n = 9,560$.

* $p < .05$.

^a Younger birth cohort = individuals aged 50-59 at the 2001 baseline. Older birth cohort = individuals aged 60+ at the 2001 baseline.

^b The indirect effect of the health pathway is assessed by health variables (chronic condition count, smoking, binge drinking and self-rated health) that reduce the education-ADL onset association.

^c Health pathway is assessed using chronic condition count and self-rated health.

^d Health pathway is assessed using chronic condition count, binge drinking and self-rated health.

^e Health pathway is assessed using binge drinking and self-rated health.

^f Health pathway is assessed using chronic condition count and self-rated health. Effects based on logistic regressions predicting ADL onset with years of education controlling for all covariates.

^g The indirect effect of the economic pathway is assessed by income and wealth in all groups as these (and not health insurance) reduced education-ADL onset associations in all groups.

** $p < .01$.

*** $p < .001$.