Early Life Conditions and Lower Body Functional Limitations in Adult Life -Evidence from the Mexican Health and Aging Study

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ABSTRACT

Using data from the Mexican Health and Aging Study (MHAS), our study investigates the effects of early life conditions on lower body functional limitations among Mexicans aged 50 years and older. We find that early life conditions are significantly associated with lower body functional limitations at older ages, even after controlling for adult characteristics. Indicators of childhood nutritional status and childhood health are significant predictors of lower body functional limitations at older ages for both males and females. The associations between early life conditions and lower body functional limitations may partially operate through adult characteristics, possibly including chronic health conditions, such as arthritis, pain, and diabetes. Moreover, the associations between early life conditions and lower body functional limitations and the underlying mechanism are found to vary by gender. For example, education predicts lower body functional limitations for females, but not males.

Introduction

Functional limitation, defined as difficulty in fulfilling basic physiological functions such as walking and lifting (Verbrugge and Jette 1994), is a key indicator of health and well-being (Berkman and Guarland 1998). It is widely observed that functional limitations are distributed unequally across socioeconomic status (SES) (House, Lantz, and Herd 2005; Schieman and Plickert 2007). Two major clusters of explanations have been advanced for the disparities in functional limitations. One attributes high prevalence of functional limitations among lower SES population primarily to their material disadvantages, such as low income, lack of housing tenure (Grundy and Glaser 2000), less access to health care, and economic hardship (Lynch, Kaplan and Shema 1997), as well as exposure to adverse physical community environments, characterized by noise, inefficient lighting, and heavy traffic (Balfour and Kaplan 2002). In developing countries, inadequate food, especially lack of nutritious food among the poor may increase their risk of functional limitations (Zohoori 2001). In addition, the poor are more likely to choose low-fare but high-risk transportation, and traffic injuries may also account for much of the high prevalence of functional limitations among the poor in developing countries (Nantulya and Reich 2002).

The other explanation emphasizes the role of behavioral and psychosocial factors in disparities in functional limitations across social classes (Schieman and Plickert 2007). Lacking education and adequate resources, the poor are more likely to develop risky behaviors, such as heavy alcohol intake and smoking (Lynch, Kaplan and Salonen 1997). Moreover, poor people are more often exposed to adverse neighborhood characteristics, such as poor roads and crime, which may discourage the desire and behavior of walking, as well as physical exercise (Huston et al.2003; Romero 2005). In turn, the accumulation of these behavioral disadvantages associated with low SES may increase the risk of functional limitations later in life. Behavioral gradients in functional health disparities are also identified in developing countries, although the pattern of the associations between socioeconomic status and healthy behaviors may differ from that in developed countries.

For example, during the "nutrition transition"[1] in China, individuals with higher SES backgrounds are more likely to have obesity problem, a risk factor of functional limitations, because of their high-fat dietary behaviors (Kim, Symons and Popkin 2004). Psychosocial factors also play an important role in disablement (Verbrugge and Jette, 1994). For example, stronger anticipated support from neighbors and higher neighborhood's collective efficacy predict good functional performance at old ages (Glass and Balfour 2003; Sampson 2003; Shaw 2005). In developing countries, psychosocial factors, such as poverty-related stress among the poor (Patel and Kleinman 2003), are also important risk factors of functional limitations, although they are usually less recognized and treated (Patel et al. 2001).

Despite the vast literature on social disparities in functional limitations, most of the research is limited to adult characteristics, and little is known about the role of early life conditions in adult functional limitations. According to the life course theory, adult health is shaped by experiences and conditions in past life stages, particularly, in childhood or even in the prenatal period (Kuh et al. 2003; Preston, Hill, and Drevenstedt 1998). Although a life course approach has been most used in chronic disease epidemiology, it is also "applicable within the context of …wider notions of health and well-being" (Ben-Shlomo and Kuh 2002: 285). Indeed, several studies in developed countries employed this approach and identified early life conditions as a risk factor of adult functional limitations. Based on data from the British 1946 Cohort Study, Guralnik et al. (2006) found that mother's education predicts well the physical performance in middle life. Father's occupation also matters. Respondents whose fathers were non-manual workers had lower risk of functional limitations than their counterparts whose fathers were manual workers. In addition, health behaviors and adult SES rarely mediate the association between childhood SES and adult functional performance (Guralnik et al. 2006). Another study in the U.S. (Luo and Waite 2005) also suggests that childhood SES remains independent influence on functional performance in adult life after controlling for both child health and adult SES. However, the underlying mechanism linking early life conditions and adult functional performance remains unspecified. Several limitations

[1] It refers to the change from a high prevalence of malnutrition to a high prevalence of overnutrition in developing countries where people tend to consume more and more high-sugar and high-fat "Western diet" (Kapoor and Anand 2002).

in previous studies also point to a need for further studies in this area. First, findings about early life conditions and adult functional limitations from these developed countries may not necessarily be valid for low and middle-income countries because of systematic differences in infrastructure, programmatic support and capital markets. For example, children born into a poor British family have access to medical services through the universal health care, but such coverage is rarely the case in less developed countries. Second, previous studies have not addressed the extent to which social inequalities in functional limitations are shaped by different dimensions of childhood experiences and conditions.

Using data from the Mexican Health and Aging Study (MHAS), we assess how early life conditions are associated with lower body functional limitations after age 50 in Mexico, a middle-income country with substantial inequalities in education and economic recourses. Specifically, we will address the following questions: 1) Are early life conditions associated with lower body functional limitations of Mexicans at older ages? 2) If so, what may be the dynamics underlying the associations between early life conditions and adult functional performance in Mexico? 3) Do these associations and mechanisms differ by gender?

Mechanisms Underlying Associations between Early Life Conditions and Adult Functional Limitation

Although a few studies have examined the associations between early life conditions and adult functional limitations, none of them has provided a systematic discussion of the underlying dynamics. Nevertheless, considerable indirect evidence from both developed countries and developing countries suggests that early life conditions may be connected with adult functional performance through a series of "chains" of social, biological, and psychological factors across the life span, in a way similar to a "pathways model" of chronic diseases (Kuh et al. 2003; Power and Hertzman 1997).

Biological Chain

Disabling chronic diseases may be a bridge connecting early life conditions and adult functional limitations. According to the disablement process model (Verbrugge and Jette 1994), functional limitation is primarily induced by pathological causes. Chronic diseases, including arthritis (Aletaha and Ward 2006; Dunlop et al. 2005; Escalante, Haas

and Del Rincon 2005), diabetes (Figaro and Simosick 2006; Lammi et al. 1989; Volpato et al. 2003), and stroke (Rozzini et al. 1997; Woo et al. 1998) are the most frequently cited causes of functional limitations. The effects of some chronic diseases or symptoms on functional performance are intuitive. For example, pain may limit physical exercise and decrease muscle strength, which may in turn lead to functional limitations (Lamb, Guralnik and Bunchner 2000; Leveille, Ling and Hochberg 2001; Scudds and Robertson 1998; Skelton et al. 1994; Snih et al. 2005). Some other chronic diseases may cause functional limitations in a more complicated way. For example, diabetes may affect functional limitations through other associated disabling disease, as well as complications of diabetes, such as hypertension and inflammation (Figaro and Simonsick 2006; Gregg et al. 2000; Peeters et al. 2001). Although which specific chronic disease is the leading cause of functional limitations varies by social context (Elders 2000), chronic diseases are widely believed to play a key role in functional limitations in both developed countries and developing countries (Boult and Yu 1996; Costa 2002; Joshi, Kumar, and Avasthi 2003; Woo et al. 1998). On the other hand, according to "fetal origin hypothesis", many adult chronic diseases, including cardiovascular diseases and diabetes may have origins in the fetal period. Specifically, insufficient fetal nutrition and consequent growth retardation of fetus may cause abnormal structure and malfunction of body system later through "biological programming", which in turn increase the risk of these chronic diseases in adulthood (Barker 1993; Barker and Clark 1997). This "biological programming" may be particularly applicable to some developing countries where the poor have experienced nutritional deprivation in early life and relatively nutritional excess in adult life, because this mismatch especially poses risks of adult chronic diseases (Adair and Prentice 2004).

Besides disabling chronic diseases, some other biological chains may work as well in bridging early life conditions and adult functional limitations. For example, muscle strength, usually measured in grip strength, is found to be closely associated with functional performance in late life. Although muscle strength is largely genetically determined (Reed et al. 1991), environmental influences on muscle strength cannot be ignored. Malnutrition during critical period may reduce the quantity of muscle fibers and catch-up development later hardly compensates for the previous loss, which may lead to

high risk of muscle weakness and consequent functional limitation (Kuh et al. 2002; Kuh et al. 2006). Moreover, an osteoporotic fracture, a well-known risk factor of functional limitation, is also found to be a likely outcome of adverse exposures in the prenatal period and infancy, such as maternal smoking and malnutrition (Cooper et al. 2002).

Social, Behavioral, and Psychosocial Chains

Intergenerational transmission of socioeconomic status is likely to be a link in a key chain connecting early life conditions to adult functional performance. The relationship between family background and individual development is widely observed in both developed countries and developing countries. In general, children with lower socioeconomic origin are less likely to finish school, because their parents have less ability or lower desire to invest in children (Becker 1991; Van de Werfhorst and Anderson 2005). In many developing countries, it has been a serious social problem that children born to poor family drop out of school at young age and become child labor to contribute to the family economy (Roggero et al. 2007). In addition, children of lower SES origin are less likely to have comparable academic performance as their higher family origin counterparts due to limited family economic resources and cultural capital (Hansen and Mastekaasa 2006). In developing countries, maternal education is found to be particularly important for children's educational achievement (Arvin and Summers 1999). In turn, the less educational achievements among children of lower family origin may affect other important developmental tasks into adulthood, such as obtaining a well-paid and secure job. Family background may also affect individual development through other resources. Children with higher SES parents are more likely to benefit from social networks and family reputation, this family benefit may have a life long impact, particularly in societies where social resources are less equally distributed (Graaf 1992; O' Rand 2001). In summary, through this intergenerational transmission of socioeconomic status, family background affects the odds of education of children, access to economic resources, occupation and other mid-life factors hypothesized to adjust the odds of late life functional limitations. For example, functional limitation is not equally distributed within occupational groups. Shift work and longer working hours are related to poor functional performance because of both physical detrimental effect and psychological pressure by family-work conflict (Sekine 2006). Certain occupations, such

as agricultural occupations are also found to be associated with high risk of arthritis, possibly because of exposure to such chemicals as pesticides (Lundberg 1994), as well as repetitive movements such as long time bending and lifting heavy objects (Mazza et al 1997). In addition, due to work environment, workers in such occupation as construction often suffer from work-related fall and injuries (Gillen et al. 1997). The work-related injuries are especially significant causes of functional limitations in developing countries (Ghaffar et al. 1999), because of the limited safety technologies and inadequate labor protection policies (Zwi 1993).

The accumulation of behavioral risk factors may also be part of the connections between early life conditions and adult functional performance. Evidence from the developed countries indicates that people raised in lower SES family are more likely to develop risky behaviors, such as alcohol abuse, smoking, and less physical exercise, due to family influence in the sensitive period of adolescence (Lynch, Kaplan and Salonen 1997; Power et al. 2005; van de Mheen et al. 1998a), and that people of lower SES are more likely to keep these risky behaviors (Minh et al. 2006). In turn, these unhealthy behaviors may pose a threat to adult functional performance. For example, heavy alcohol consumption is associated with adult functional limitations (Cawthon et al. 2007). One explanation is that heavy drinking may cause lower bone mineral density (BMD), which itself is a significant predictor of fall and fracture as well as consequent functional limitation (Cawthon et al. 2006). In addition, less physical exercise and unhealthy dietary behavior may considerably contribute to overweight and obesity, which in turn increase risk of functional limitations later in life, partly through their associations with joint problem and knee osteoarthritis (Kondo et al. 2006). The British 1946-birth cohort study also revealed that the association between childhood SES and middle age function is mediated by BMI and behavioral risk factors, although only to a modest extent (Guralnik et al. 2006). Similarly, it has also been found in developing countries that in general lower SES individuals or individuals born into lower SES family have more unhealthy behaviors, such as smoking, and these unhealthy behaviors may lead to higher risk of functional limitations (Ebrahim et al. 2007; Minh et al. 2006; Rozi and Akhtar 2004), except for the mixed evidence that the poor are more likely to have unhealthy dietary behaviors, such as high-fat intake in different developing countries. In fact, because of

the rapid expansion of tobacco using and other risky behaviors to developing countries (Ebrahim et al. 2007), behavioral factors may be of increasing significance in mediating the association between family SES or individual SES and adult functional limitations in developing countries.

Psychosocial factors may also bridge early life conditions and adult functional performance. Psychosocial factors may impact functional performance independently. For instance, sizable social network and active social interaction (Seeman, Bruce, and McAvay 1996), religious service attendance (Levin 1996), as well as high self-efficacy (Mendes de Leon et al. 2001), are found to be protective against functional decline, net of education and income. Family environment plays an important role in shaping psychosocial development in early life. For example, family economic hardship in early life may reduce the adolescent's sense of control over time, which in turn produces emotional distress (Conger et al. 1999).

Community-level Factors/Neighborhood Effect

Consistent evidence demonstrates that community characteristics may be important to resident's health, measured as morbidity (Diez-Roux et al. 1997; Ellaway, Anderson, and Macintyre 1997), mortality risk (Yen and Kaplan 1999a), psychological well being (Yen and Kaplan 1999b), and late-life disability (Lin and Zimmer 2002). Verbrugge and Jette (1994) also point out that environment plays an important role in disablement process. Neighborhood choice itself reflects the family SES and adult SES of residents, but there is still considerable heterogeneity inside neighborhood in living standards. A study based on Demographic and Health Surveys (DHS) in developing countries suggests that poor households do not necessarily live in poor communities; similarly, high SES households may live in the communities where majority of neighbors are poor (Montgomery and Hewett 2004). In the following we will focus on how neighborhood/community characteristics may be associated with adult functional performance, above the family SES in early life and adult SES, particularly in the context of developing countries.

Community may influence functional performance through its association with nutritional status of residents, especially that of the children. The community in early life is where a child is raised and it contributes much to the child's development and health (Paknawin-Mock et al. 2000). Community characteristics, such as the distance to the

nearest store and local food price, are likely to affect the nutritional condition in childhood (Strauss 1990). A study in Guatemala also suggests that community characteristics are significantly associated with mother's use of prenatal service, after adjustment of individual-level characteristics (Pebley, Goldman and Rodriguez 1996). Living in different communities also means difference in residents' exposures to infectious diseases. Evidence suggests that infectious diseases, such as malaria, are (spatially) heterogeneously distributed, and they are usually more prevalent in communities characterized by a lack of such basic facilities as piped water and sewer, as well as community services (Alderman and Garcia 1993). Giving the important role of childhood health and nutrition in adult functional performance, community characteristics in early life may further be associated with adult functional performance through their associations with childhood health and nutritional conditions.

Functional performance may also be associated with the characteristics of neighborhood in adult life, such as community violence. Rapid urbanization and neighborhood poverty may increase the risk of neighborhood violence, partly because of weak social control (Petereson and Krivo 1993; Miles-Doan 1998). A study in Mexico reported that there were significant regional differentials in lifetime exposure to neighborhood violence (Baker et al. 2005). Besides, other physical measurements, such as quality of street, traffic, noise, and pollution are also found to predict adult functional performance (Huston et al. 2003; Stariano 1997). The community characteristics may be more relevant to the functional performance of older residents, because the elderly are likely to restrict their daily activities to inside the communities, and are more likely to resort to local resource for medical and other problems (Basta 2007; Schootman et al. 2006). In addition, they are more vulnerable to any detrimental neighborhood effect (Krause 1993; Schootman et al. 2006).

It is not plausible that any single chain could fully account for the association between early life conditions and adult functional performance. Instead, the dynamics underlying the development of functional limitations should be understood as a complicated combination of biological, social, behavioral and psychosocial forces, and these forces may work additively or interactively in shaping functional performance. For example, based on a Taiwan data, Lin et al. (2004) found that chronic diseases are less

disabling for educated and wealthy males who are more likely to utilize medical interventions than others (Lin et al. 2004). Empirical evidence also suggests that social environments may affect the role of diseases in disabling process. In some developing countries, epilepsy is often misinterpreted as stigmatizing diseases (Murthy 2003), and child with epilepsy may be subjected to social isolation and less access to medical services, which results in high prevalence of functional problems among people with epilepsy (Abang 1988).

Figure 1 shows schematically how early- and mid-life conditions may be associated with adult functional performance through multiple paths. Specifically, child SES may affect functional performance through their associations with chronic diseases. They may also operate through the related adult characteristics, such as adult SES and health behaviors. Childhood health may connect childhood SES to adult functional limitations through adult SES, with or without any mediator. Other possible paths, such as neighborhood, may work as well connecting early life conditions and adult functional limitations.

The Mexican Setting

During the first half of the last century, Mexico achieved dramatic improvements in population health[1], through a series of public health campaigns[2] (Gueto 2005). However, it is unlikely that all Mexicans benefited equally from these health campaigns. The health campaigns themselves were not "objective and apolitical". Moreover, perceptions of health and attitudes toward health campaigns varied across social groups (Armus 2005; Laveaga 2007). For example, indigenous groups were less receptive to these campaigns because of conflict between their indigenous beliefs and modern health practices. As a result, the health campaigns failed to eliminate social and regional difference in prevalence of communicable diseases. For example, malaria persisted in some regions, predominately rural areas after the health campaigns (Gueto 2005). Mexico of that period also experienced rapid industrialization and urban development. Unfortunately, the consequent improvement in living standards was limited to elite and upper middle

[1] As an indicator, life expectancy at birth increased from 30 years in 1900 to around 50 years in 1950 (Partida-Bush 2005).

[2] For example, the Rockefeller Foundation campaign 1921-1951 and anti-malaria campaign launched in 1950s.

classes, rather than blue-collar classes. The disparities among social classes were likely to be enlarged during this period. As an indicator of such differentials, the adult height of laboring class stagnated for decades, while that of the upper and upper middle classes increased significantly during the same period (Bortz 1988; Lopez Alonso 2007).

The socioeconomic aspect and epidemiological profile of Mexico before 1950s suggests that Mexicans born during that period were likely to differ by family origin in nutritional conditions and disease burden in early life. In particular, because of the relatively low child mortality, the deprived early life may lead to inferior adult health outcomes for Mexicans born into poor families, rather than an instant significant "survival selection". The same cohort may continue to be exposed to severe social inequalities that persisted in Mexico[2] during their middle and late life. According to World Bank, around 20% of Mexicans were still in extreme poverty in 2002, and more than half of the households in Mexico were not covered by any health insurance. A healthcare reform has been recently proposed to provide Mexicans with universal health coverage. Unfortunately, the target is more than hard to achieve because of a series of challenges (Knaul and Fenk 2005). Compared to poor Mexicans, the upper and upper middle classes have much easier access to multiple health care systems that provide quality medical services comparable to those in developed countries (Barraza-Llorens et al. 2002).

In addition, high prevalence and unequal distribution of obesity and diabetes may pose different threats for functional limitations among individuals of various socioeconomic statuses in Mexico. The prevalence of diabetes is growing very fast in Mexico. It is currently estimated to be around 8% among adult Mexicans, with a higher prevalence in urban than rural area (Aguilar-Salinas et al. 2001; Lara et al. 2004). Overweight and obesity are also very common in Mexico, particularly among the lower socioeconomic status population. The prevalence of overweight and obesity among the poor in Mexico is estimated to be over 50% (Fernald et al. 2004).

[2]According to the United Nations, Mexico's GENI coefficient is 54.6, ranking 109th among 194 countries in the world, which means that 108 countries have higher degree of social equality than Mexico.

Data and Measurement

In this study, we mainly use the second wave (2003) of the Mexican Health and Aging Study (MHAS), except that information about childhood health, respondent's education and employment comes from the baseline survey in 2001. The second wave of MHAS provides more information about early life conditions of respondents than the baseline survey in 2001. We also use the 2000 Mexican Census of Population and Dwelling and the 2002 Directory of Public Health Sector Facilities for community-level variables. MHAS provides a unique opportunity to this study of early life conditions and late-life functional limitations, as it claims that

> "Mid-and late-life health is shaped by an unusual interaction between current chronic disease risk and residual effects of infectious diseases in early life", and thus one goal of MHAS is to examine "whether this process yields high levels of chronic disease, symptoms, and disability in old age" (MHAS project, http://www.mhas.pop.upenn.edu/english/project.htm)

In this study, we restrict our sample to Mexicans aged 50 years and older in the second wave of MHAS in 2003[3]. In addition, we include only respondents with a direct interview since information including functional status is not available for respondents with a proxy interview[4].

Measuring Dependent Variable

MHAS uses 12 Nagi-like items to measure functional performance. Each item starts with "because of a health problem, do you have difficulty with (the following item)". The respondents might respond "yes", "no", "can't do", "doesn't do", and "don't know", or refuse to answer. MHAS employs a skip strategy in collecting information about functional limitations. Respondents are not asked about performance of less challenging activities if they have no trouble with more challenging ones. For example, the respondents having no trouble to walk several blocks are not asked about whether they

[3] Strictly speaking, our sample is not a nationally representative sample of Mexicans. It includes a nationally representative sample of Mexicans born prior to 1951 and their spouse/partners regardless of the age. In our sample, 365 out of 12,336 Mexicans were born after 1950.

[4] 1,597 out of 12, 336 Mexicans aged 50 and above in 2003 MHAS are proxy respondents. The mean age of the proxy respondents is 66.0, compared to 63.9 for respondents in direct interview.

can walk one block (they are correspondently coded in our study as “having no trouble” to walk one block).

This paper is restricted to lower body limitations measured with the following eight items: “running a mile”, “walking several blocks”, “walking one block”, “climbing several stairs”, “climbing one stair”, “sitting for two hours”, “getting from chair after sitting for long periods”, and “stooping, kneeling, or crouching”. It is reported that lower body limitations more accurately predict disability than upper body limitations across diverse populations (Guralnik et al. 2000). For each of the eight items, value of one is assigned to those whose answer was “having trouble”, “can’t do”, or “doesn’t do”, and value of zero is assigned to those who had “no trouble”. The respondent whose answer was “don’t know” or who refused to answer is excluded from the sample as cases with missing values. Table A1 in Appendix shows the distribution for each of these eight items. “Running a mile” appears to be the most difficult task for the Mexicans aged 50 and older, around one third of them had trouble to perform this task. In contrast, only around 12% of the Mexicans aged 50 and older had trouble “walking one block”.

We then sum up all the eight items and get a value ranging from zero to eight (the higher the number, the more severe the lower body limitations). We specify two distinct measures of lower body functional limitations. The first measures existence of any lower body functional limitation (“having no lower body functional limitation” versus “having at least one lower body functional limitation). The second is through an ordered categorical variable measuring severity of lower body functional limitations among those who had at least one lower body functional limitation. Three levels of severity, including “slight limitation”, “moderate limitation”, and “serious limitation”, are specified as the summed value of items ranges “1-2”, “3-5”, “6-8”, correspondingly.

Explanatory Variables

Early Life Conditions

Taking advantage of the rich information on conditions and experiences over respondents’ life course in MHAS, we capture several dimensions of childhood exposures outlined in the conceptual framework (Figure 1), including whether the respondent was born in a high-migration state, whether the respondent’s residence was

urban when living with parents in early life, father's occupation, mother's education, and number of siblings born alive (sibship size or family size is also used hereafter), as well as three measures indicating conditions before age 10 along dimensions of sanitation, nutrition, and financial situation as follows:

1) "Did the residence have a toilet inside the house",

2) "Did you generally go to bed hungry",

3)"Did you or your family receive help from relatives because of economic problems".

Previous studies suggest that parents' education has a long-term influence on children's health and development. Turrell et al. (2002) reported a significant association between parents' education and cognitive function of children in late middle age (Turrell et al. 2002). We use only mother's education in this study, because mother's education is highly correlated with father's education (the correlation is approximately 0.7). In addition, mother's education well indicates child health inequalities between families and education outcomes of children (Heckman and Hotz 1986; Wamani et al. 2004). In a series of health campaigns to eliminate the infectious diseases in the early 20th century, Mexican mothers were found to play a key role (Laveaga 2005). We code mother's education into four levels including no education, some elementary, and completed elementary education, and primary school and above.

As an important household characteristic, father's occupation is categorized into five types as follows: 1) agriculture, 2) construction, 3) office/professional, 4) gardening /maintenance/service/restaurant/store/hotel, and 5) childcare or domestic work for a private residence, other occupations that were not included in the questionnaires, didn't work, and didn't have a father or a guardian.

Many studies have reported a negative association between sibship size (family size) and children's intellectual development (Blake 1981; Downey 1995) or health outcomes (Ponsonby et al. 1998; Westergaard et al. 2005), which is interpreted that the larger the family size, the more likely a child will need to leave school at young age to work and contribute financial resources to the family. Based on the number of siblings born alive, sibship size is coded as "no sibling", "1-3", "4-6", "7-9", and "10+".

In our study, we also include a dummy variable "whether born in a high-migration state"[5] to proxy early life conditions of these respondents. Migration to the US is a common experience for Mexicans. It is plausible to assume that household heads in the high-migration states are more likely to emigrate to the U.S than others. The impact of household head's migration on children is under debate. Parents' migration may compromise children's health because of the resulted absence of economic and social support to children in the short run (Kanaiaupuni and Donato 1999). On the other hand, migration of the household head may improve the health outcomes of children, mainly through the remittance sent back home and health knowledge acquired in the U.S. (Hildebrandt and McKenzie 2005). The diffusion of health knowledge among residents in high-migration states may also benefit respondents whose parents did not emigrate to the U.S.

Childhood Health

Childhood health plays an important role in adult health conditions, educational achievement and occupational development later in life (van de Mheen, et al. 1998b). In this study, childhood health is evaluated by whether the respondent had any of the following illnesses or health problems: tuberculosis, rheumatic fever, polio, typhoid fever, and a serious blow to the head that made respondent faint before age 10. If a respondent had any of the above, he or she is coded as "had serious health problem before age 10".

Adult Characteristics

Consistent evidence shows a connection between functional performance later in life and adult characteristics, especially socio-economic status (SES), regardless of the measurement of SES. For example, income is found to have an independent effect on functional performance, after controlling for education, occupation, and other factors (Berkman and Gurland 1998). Some occupations may increase the risk of hip fracture (Suen 1998). Other occupations may cause such sensory impairments, which may in turn

[5] It refers to six states with the top migration rates, namely, Durango, Guanajuato, Jalisco, Michoacán, Nayarit, and Zacatecas.

lead to functional limitations later in life (Daniell et al. 1998). With the weakening of traditional family support in Mexico, the socioeconomic status of the elderly is becoming more and more important to their health (Smith and Goldman 2007). In Mexico, occupation is strongly related to access to medical service. Some public health insurance programs, such as Institute of Security and Social Service (ISSSTE), provide health care only to state workers and government employees. Some special industries and organizations have their own health care programs, such as *Pemex* of Mexican Petroleum (Knaul and Fenk 2005). In turn, the occupation-based differentials in availability and access to medical care may affect the health (including physical functions) of Mexicans in different occupations.

The current study uses multiple indicators of adult SES, including education, occupation, income and assets. Such a multiple-dimension measurement may be more appropriate than any single indicator, because each indicator may affect functional limitations through distinct mechanisms. For example, it is reported that education affects the onset of functional problems primarily through psychosocial mechanism, while income influences both onset and progression of functional limitations through psychosocial and biomedical mechanisms (Zimmer and House 2003).

Education of Respondents. Mexico's education system was very complex above elementary school[6]. Briefly, besides high school, there are also technical, commercial, and basic teaching schools for non college-bound students at high school age. We combine the level of high school, technical school, and normal school into one level of "high school".

In MHAS, there are many respondents leaving school before graduation at each education level, especially at the primary school level. We code the education of those who left primary school before graduation as "some primary". School drops-outs at the mechanical or commercial level, with more necessary training, are more likely to work as skilled personnel than a lower level graduate (Myers 1965). We code education as follows: 1) none, 2) some primary, 3) completed primary, 4) junior high, and 5) high school and above.

[6] It is very complex due to "its multi-track system leading to both university entrance and to terminal points at various levels below university entrance"(Myders, 1965. *Education and National Development in Mexico:* 90)

Occupation of Respondents. Occupational characteristics, including workplace environments and degree of job hazards, may affect functional performance in late life. MHAS provides detailed information about employment history, including the first job, the main job throughout life, the location of these jobs, and the role of respondents in job. This paper uses only the information about main job and we recode these jobs into six categories[7] as follows:

1) Professional or administrative personnel. This category includes professionals and technicians; educators; as well as workers in art, show, and sports. The administrative personnel include officials and directors in the public, private, and social sector; bosses, supervisors, etc. in artistic and industrial production and in repair and maintenance activities; as well as department heads, coordinators, and supervisors in administrative and service activities.
2) Workers in agriculture, livestock, forestry, and fishing.
3) Workers in industry, including artisans and workers in production, repair, and maintenance; operators of machinery and equipment for industrial production; and assistants, laborers, etc in industrial production, repair, and maintenance.
4) Office staff, including administrative support staff; merchants and sales representatives; traveling salespeople and traveling salespeople of services.
5) Service, including both workers in service industry and domestic service workers.
6) Others, including drivers and assistant drivers of mobile machinery and transport vehicles; safety and security personnel; other workers in occupations not classified; as well as those who were unemployed (never had a paid job and never helped in a business, farm, or ranch without receiving payment or profit). For females who fall into this category, they are almost exclusively unemployed. For males who fall into this category, around 65% are drivers and assistant drivers, around 25% are safety and security personnel, very few (less than 4%) are unemployed.

Income/Assets of Respondents. MHAS is the first survey that collected information about assets for the Mexican population at any age (Wong and Espinoza 2002). In MHAS, dozens of questions in several sections of the survey are involved in measuring

[7] Respondents in MHAS report hundreds of occupations. The coding is based on the *Structure of the Mexican Classification of Occupations*-INEGI.

income and assets, based on which total income at the individual level and net worth at couple level are constructed[8]. One noteworthy issue here is the possibility that the respondent had negative income and assets. In MHAS, debts, and expenditure are also considered in the calculation of total assets and total income, respectively, which makes the negative values possible (Wong and Espinoza 2002). Another issue is missing data. For cases with missing values (either complete non-response or information available in a format of unfolding bracket rather than exact value), imputed values have already been filled in by the investigators of MHAS with the imputing method discussed by Wong and Espinoza (2004). To code the income variable, we separate negative income as a single category and evenly divide each sex of respondents with positive income into four quartiles, according to sex-specific distribution of income. Similarly, to code assets variable, we separate negative assets as a single category and evenly divide each sex of respondents with positive assets into four quartiles, according to sex-specific distribution of assets.

Smoking Behavior. Family environment may affect health behaviors (Lynch et al. 1997). Besides the status of smoking/non-smoking, the age at which smoker initiated smoking may also be an important indicator of the possible influence of family background. Therefore we recode smoking into a categorical variable with three categories: “never smoked”, “started smoking before age 16”, and “started smoking at age16 or older”.

Marital Status. We code marital status as a dummy variable “whether married or in a consensual union”. The omitted category includes all other marital status, including single, divorced, separated from a union, separated from a marriage, widowed from a union, and windowed from a marriage.

Chronic Health Conditions

In MHAS respondents were asked a series of questions about current health conditions and medical history. We choose three indicators of chronic health conditions and symptoms, including diabetes, arthritis, and pain. In previous studies, these chronic diseases and symptoms were found to well predict functional limitations (Aletaha and Ward 2006; Dunlop et al. 2005; Figaro and Simosick 2006; Snih et al 2005; Volpato et al.

[8] See Wong and Espinoza 2004 for details about the calculation of these values.

2003), and they are fairly prevalent in Mexico. In addition, these chronic diseases are less likely to be caused by functional limitations; rather they are more likely to be related to other causes including previous life events and conditions. For example, back pain may be caused by physically demanding work (Mustard et al. 2005). Moreover, diabetes was found to have a strong and persistent association with early life conditions, especially mother's education among older Mexicans (Kohler and Soldo 2005).

The Community-level Variables

This study relies on MHAS-linked files of community-level resources from: 1) The community-level file of the 2000 Mexican Census of Population and Dwelling[9], and 2) The 2002 Directory of Public Health Sector Facilities[10]. We use three measurements of community characteristics as follows: 1) the number of doctors per 10, 000 residents inside the community; 2) the proportion of people 15 years old and above with some/complete higher education; and 3) the proportion of people who have below minimum wage. According to a critical review (Pickett and Pearl 2001), the three indicators are also widely used as indicators of neighborhood characteristics and have been proved to be good predictors of health inequalities across communities. The first proxy measures the medical resources in the community. Medical resource inside the community are important in disablement process, particular for the aged who are much likely to resort to local medical services when they have medical problems (Schootman et al. 2006). In Mexico, the number of doctors per 10, 000 residents may also capture the regional differentials in economic, political and social characteristics. Traditionally, as the most underdeveloped regions, southern states such as Chiapas and Oaxaca suffer from doctor scarcity, while the northern states, especially the urban areas, have a much denser distribution of doctors (Nigenda 1997). The second proxy measures the community-level education attainment. It was reported that education attainment of neighbors is associated with health outcomes including physical functioning, after

[9] Provided by INEGI (Instituto Nacional de Estadistica, Georgraia e Informatica) in Mexico. Small communities are omitted from this linked file to protect the confidentiality of residents (which also causes a modest missing data problem for community-level variables).

[10] Provided by Mexican Ministry of Health. Two noteworthy issues: first, a small number of households having no public health facilities inside community are assigned information about the neighboring community. Second, only information about public services inside communities are provided.

controlling for individual-level characteristics (Wainwright and Surtees 2003; Wight et al. 2005). Presence of highly educated neighbors may improve the health of all the residents in the neighborhood through diffusion of health knowledge and introduction of health resources (Galea and Ahern 2005). The third proxy measures the poverty level of the community. It was suggested that compared to income inequality, community-level poverty is a better predictor of health outcomes (Fiscella and Franks 1997). Community-level poverty may affect physical function through its association with obesity (Wickrama, Wichrama and Bryant 2006), violence and consequent injuries (Hay et al. 2006), as well as infectious diseases (Cantwell et al. 1998). In Mexico, traffic injuries are serious public health concerns. There are significant regional patterns and differences in these injuries, which may be associated with a variety of community characteristics, including concentrated disadvantages that are measured by proportion of residents having higher education and proportion of residents having below-minimum wage (Inclan, Hijar and Tovar 2005).

Although the measurements are linked to only the communities in which the respondents currently live, they are likely to capture the long-term environmental exposures for vast majority of the respondents. Table 1.1 shows that around half of the respondents always lived in or moved before age 15 to their current communities, and only less than 8% of respondents moved to their current communities after age 50.

Analytic Strategy

This study uses a two-stage analytical approach (Manning, Duan, and Rogers 1987; Zimmer, Hermalin and Lin 2002). The first stage tests how early life conditions are associated with existence of any lower body functional limitation. In Model 1, age and early life conditions are included. In Model 2, only childhood health is added. As indicated in the theoretical framework (Figure1), childhood health may be an important mediator connecting early life conditions and adult functional performance. For example, lower family SES may lead to poor childhood health, which in turn impacts adult socioeconomic achievement (Haas 2006). This socioeconomic disadvantage could be translated into poor functional performance in adult life (House, Kessler and Herzog 1990). In Model 3, several adult characteristics, including adult SES, marital status, and

smoking behavior, are incorporated. Finally, chronic health conditions are added to Model 4. By employing these nested models, we can test whether the newly added factors mediate the associations between lower body functional limitations and factors in previous models.

Model 1:

$$\log\left(\frac{f}{1-f}\right)=\alpha+\beta_1 X_{age}+\beta_2 X_{Childhood\_conditions}+\varepsilon$$

Model 2:

$$\log\left(\frac{f}{1-f}\right)=\alpha+\beta_1 X_{age}+\beta_2 X_{Childhood\_conditions}+\beta_3 X_{Childhood\_health}+\varepsilon$$

Model 3:

$$\log\left(\frac{f}{1-f}\right)=\alpha+\beta_1 X_{age}+\beta_2 X_{Childhood\_conditions}+\beta_3 X_{Childhood\_health}+\beta_4 X_{adult\_characteristics}+\varepsilon$$

Model 4:

$$\log\left(\frac{f}{1-f}\right)=\alpha+\beta_1 X_{age}+\beta_2 X_{Childhood\_conditions}+\beta_3 X_{Childhood\_health}+\beta_4 X_{adult\_characteristics}+\beta_5 X_{Chronics}+\varepsilon$$

The second stage tests whether early life conditions are associated with severity of lower body functional limitations among respondents who have at least one lower body functional limitation. The estimation follows the same analytical strategy as described above and contains a set of cumulative logit models. Specifically, P_j is the probability of the dependent variable falling into category j, where sequence j=1, 2, 3, which refers to "slight limitation", "moderate limitation", and "serious limitation", respectively. We then define cumulative probability $f_j=\sum_{m=1}^{j} P_m$, where f_j is the probability of being in the jth category or lower. For example, f_2 here means the probability of having slight limitation or moderate limitation. Finally, the cumulative logit model can be specified as

$$\log\left(\frac{f_j}{1-f_j}\right)=a+\beta X$$

From Model 1 to Model 4, early life conditions, childhood health, adult characteristics, and chronic health conditions will be included in the vector X in a series of nested models.

Incorporating Community-level Variables into Multilevel Analysis

To take community-level factors into consideration, we employ a multilevel model, with a random effects hypothesis, as shown below.

$\log\left(\frac{f_{ic}}{1-f_{ic}}\right) = \alpha + \beta X_{ic} + \lambda Z_c + \varepsilon_c$ Where X_{ic} represents a vector of variables that describe individuals within each community, including age, early life conditions, childhood health, and adult characteristics. We also control for the time that respondent moved in the current location (community). Z_c refers to a vector of variables that describe the community, namely, number of doctors per 10,000 resident in the community, proportion of residents aged 15 and older with higher education, and proportion of residents under minimum wages. ε_c is a random disturbance that is specific to communities. The multilevel models were estimated with the HLM software version 6.0 (Bryk, Raudenbush and Congdon 1996).

In this study, we estimate all the models discussed above separately for males and females. Previous studies have found that social inequalities in health and the underlying mechanisms vary by gender. For example, education may affect health and mortality through different pathways for males and females (Christenson and Johnson 1995). We also test whether the associations between the explanatory variables and lower body functional limitations vary by gender.

Results

Descriptive Statistics

Table 1.1shows that females reported higher prevalence of lower body functional limitations than males. Around 35% males had no lower body functional limitations, while only around 20% females were free of such limitations. In addition, less than 12% of the males reported serious lower body functional limitations, compared to around 19% of the females. Figure 2.1 and Figure 2.2 show the distribution of lower body functional limitations by age group for males and females, respectively. In general, for both males

and females, the proportion with any lower body functional limitations increases with age, as does the proportion with serious lower body functional limitations.

Turning to Table 1.1, many respondents were exposed to adverse early life conditions. As shown, more than 30% of the respondents of both sexes reported that they "went to bed hungry before age 10". Around 9% of the respondents reported that their "family received financial help before age 10", and around 11% of the respondents reported that they "had serious health problems before age 10". In addition, about half of the respondents' mothers had no schooling. More than half of the respondents' fathers worked in agriculture, compared to less than 3% in "an office/ professional". Many respondents had a big family, and around 17% of the males and 20% of the females had ten or more siblings.

Regarding adult SES, more than 20% of the respondents had no schooling, and males had somewhat higher levels of education than females. Almost all males (around 99.5%) had jobs, while around 32% females were unemployed[11]. Partially for this reason, males had better financial situation than females. As Table 1.1 shows, only 10% of the males had no income or had negative income, compared to more than 20% of the females.

Except for age and the variable "born in a high migration state", all other variables shown in Table 1.1 and Table 1.2 have missing data. The variable having the most serious missing data problem is mother's education, making up approximately 50% of the total missing cases. We excluded 2,029 cases having missing value on any variable from the initial sample, which yields a sample of 8,710, including 5,034 females and 3,676 males. To test whether the deletion of cases with missing data affects the estimation, we will evaluate the robustness of estimation with sensitivity analysis in the end.

The Influence of Early Life Conditions on Existence of Any Functional Limitations

Model 1 in Table 2.1 reports the associations between existence of any lower body functional limitations and early life conditions for males, controlling for age. As shown,

[11] For females, the "other" category of variable "respondent's occupation" consists mainly of the unemployed.

age is a significant predictor. For males, each ten years increase in age doubles the odds of having any lower body functional limitations[12]. Several indicators of early life conditions well predict the occurrence of any lower body functional limitations for males. Specifically, males born in high migration states were less likely to have any lower body functional limitation compared to their counterparts born in other states. In addition, having toilet inside house before age 10 is associated with lower risk of lower body functional limitations. Not surprisingly, males who often went to bed hungry and males whose family received financial help are at higher risk of having some lower body functional limitations. In addition, excess number of siblings born alive is significantly associated with existence of any lower body functional limitation for males. Compared to males having modest number (1-3) of siblings, males who have more than ten siblings are more likely to have some lower body functional limitations. In addition, males who lived in urban area with parents in early life have a higher risk of lower body functional limitation, which is possibly due to worse sanitation and higher prevalence of infectious diseases in urban than rural area in the early life of the respondents. Similar findings have also been reported in comparative studies of morbidity among rural versus urban residents in early stage of industrialization in Europe and other regions (Lewis 2002).

As Model 2 shows, childhood health is also associated with lower body functional limitations later in life for males, although the association is only marginally statistically significant. Compared to Model 1, the introduction of childhood health variable to Model 2 had little effect on estimates of early life conditions.

Of the adult characteristics added to Model 3, only smoking behavior and marital status are significantly associated with existence of any lower body functional limitations. Being married or in a consensual union predicts higher risk of occurrence of any lower body functional limitation. Compared to males who never smoked, males who initiated smoking before age 16 have much higher risk of lower body functional limitations, followed by male smokers who initiated smoking at age 16 and older. With introduction of adult characteristics in Model 3, coefficient of “had toilet inside house before age 10” goes up approximately 10%, and this increase suggests that adult characteristics may

[12] It could be calculated as $1.07^{10}=2$

mediate the association between this measurement of early life conditions and existence of any adult lower body functional limitations.

Diabetes, arthritis, and pain, three indicators of chronic diseases are introduced in Model 4. As shown, each indicator is a significant predicator of lower body functional limitations. In general, males with chronic diseases are more likely to have some lower body functional limitations than males who are free of these chronic diseases and symptoms. The introduction of chronic diseases in Model 4 reduces the magnitude of coefficient of childhood health. We are cautious about interpreting this as strong evidence that the chronic diseases are the paths connecting childhood health and lower body functional limitations, since chronics diseases and childhood health may be caused by some common risk factors such as genetic defect. Moreover, functional limitations may precede some chronic diseases.

Table 2.2 report results for females. Model 1 reports the associations between existence of any lower body functional limitations and early life conditions, controlling for age. Similar to the results for the males, age well predicts occurrence of any lower body functional limitations, and this deterioration with age appears to be slower for females than for males, with each fourteen years[13] increase in age doubling the odds of having any lower body functional limitations for females. Born in a high migration state and three indicators of conditions before age 10 exhibit significant associations with existence of any lower body functional limitations. In addition, compared to females whose fathers worked in agriculture, females who had no fathers/guardians and females whose fathers had "other" work have higher risk of lower body functional limitations. Possibly, the "other" refers to such unstable and low-paid jobs that may suggest high risk of family financial hardship in early life of respondents. This interpretation is consistent with the association between family receiving financial help and existence of any lower body functional limitations.

In Model 2, childhood health is added. Females who had serious health problems before age 10 have significantly higher risk of lower body functional limitations than those who had no such health problems. The results also suggest that incorporation of

[13] It could be calculated as $1.05^{14}=2$

childhood health does not affect the association between early life conditions and lower body functional limitations later in life.

As Model 3 shows, among adult characteristics, occupation and smoking behavior are associated with lower body functional limitations of females. Compared to females who worked in agriculture or forestry, females who worked as professional or administrative personal are less likely to have any lower body functional limitations. For females, nonsmokers have the lowest risk of lower body functional limitations, followed by smokers who initiated smoking at age 16 or older. The incorporation of adult characteristics changed coefficients of "had toilet inside house before age 10" and "went to bad hungry before age 10", in a similar pattern as males.

In Model 4, chronic diseases exhibit similar associations with lower body functional limitations for females as for males. Specifically, all these indicators of chronic health conditions predict well the existence of any lower body functional limitations. In addition, incorporation of chronic health conditions reduces the effect of childhood health by approximately 10%.

The Influence of Early Life Conditions on Severity of Lower Body Functional Limitations

As shown in Table 3.1 (Model 1), age predicts severity of lower body functional limitations, and older males have more severe lower body functional limitations. Among proxies of early life conditions, the variable "often went to bed hungry before age 10" is the only significant predictor of severity of lower body functional limitations for males. Males who often went to bed hungry before age 10 have more severe lower body functional limitations than those who did not.

Model 2 suggests that childhood health is an important predictor of severity of lower body functional limitations. Males who had serious health problems before age 10 have more severe limitations. As shown in Model 3, adult characteristics also predict severity. Males who worked as professional or administrative personnel have less severe lower body functional limitations compared to males who worked in agriculture or forestry. In addition, individual income is associated with severity of lower body functional limitations. Compared to the reference groups (males whose income falls in the first quartile), males whose income falls in the third quartile have less severe lower

body functional limitations; males who have no income or have negative income have more severe lower body functional limitations, with a marginal significance. Smoking behavior also predicts severity of lower body functional limitations for males. Smokers who started smoking at age 16 or older have the most severe lower body functional limitations, followed by males who started smoking before age 16.

In Model 4, each indicator of chronic health conditions predicts severity of lower body functional limitations. In addition, the incorporation of chronic health conditions in adulthood reduces the magnitude of the coefficients for "had serious health problem before age 10" and "often went to bed hungry before age 10", which suggests that chronic diseases may be mediators between early life experiences and severity of lower body functional limitations in adulthood. However, again, we should be cautious in making any causal inference from these observed associations given the similar concerns as we discussed above for the case of existence of any lower body functional limitations.

The results for severity of lower body functional limitations for females are shown in Table 3.2. Model 1 shows the estimates for early life conditions, net of age. Similar to age effect on severity of lower body functional limitations for males, older females have more severe lower body functional limitations than younger females. "Often went to bed hungry before age 10" and "family received financial help before age 10" predict more severe lower body functional limitations. Father's occupation is also a significant predictor such that females whose fathers worked in "gardening/…/hotel" and females whose fathers worked in construction have more severe lower body functional limitations than females whose fathers worked in agriculture or forestry. In addition, females having a big sibship size (10+) report more severe lower body functional limitations than females who have a modest number of siblings (1-3). Mother's education exhibits some protective effect against severe lower body functional limitations. Although the education effect is significant only at the level of some elementary education, the sizes of the coefficients are very similar at higher levels of education.

Childhood health in Model 2 predicts the severity of lower body functional limitations. Females who had serious health problems before age 10 reported more severe lower body functional limitations than females without such health problems. These results are very similar to those from males.

As Model 3 shows, the respondent's own educational attainment exhibits significant protective effect against more severe lower body functional limitations. Females with higher levels of schoolings are less likely to report severe lower body functional limitations. Surprisingly, compared to females who worked in agriculture or forestry, females who worked as professional or administrative personnel have more severe lower body functional limitations, although they were less likely to report that they had any.

In Model 4, all the indicators of chronic health conditions predict the severity of lower body functional limitations for females. After controlling for chronic health conditions, the magnitude of the coefficient for "had serious health problem before age 10" declines by 10%, and it is no longer significant.

Estimates of Ecological Effects in Multilevel Models

Table 4 reports the inter-class correlations from empty models when neither individual-level nor community-level covariates are included. Specifically, the total variance of having any lower body functional limitations is the sum of individual level variance[14] and community level variance, and the inter-class correlation of community is equal to community variance divided by total variance. As shown in Table 4, the inter-class correlations for the existence of any lower body functional limitations are estimated to be 0.09 and 0.08, for females and males respectively. And the inter-class correlations for the severity of lower body functional limitations are 0.07 and 0.02, for females and males respectively. Although these inter-class correlations are only modest, they suggest that the models may be improved by incorporating community-level characteristics.

Results of bivariate analysis of community-level predictors in Table 5 suggest that the proportion of people aged 15 and older with higher education and the proportion of people below minimum wage are significant predictors of existence of any lower body functional limitations for males. After controlling for all community-level variables simultaneously, only the coefficient of "proportion of people aged 15 and older with higher education" remains significant for males. Compared to Mexicans who lived in the communities with lower proportion of people aged 15 and above with higher education,

[14] It equals to $\pi^2/3=3.29$ in logit model, see Goldstein, Browne and Rasbash (2002) for a more specific discussion.

Mexicans who lived in the communities with higher proportion of people aged 15 and above with higher education are less likely to have any lower body functional limitations for males. Table 6 shows the association between the three community-level characteristics and severity of lower body functional limitations. For both males and females, the proportion of people aged 15 and older with higher education is significantly and negatively associated with severity of lower body functional limitations in both bivariate and multivariate models including all community-level variables simultaneously. In addition, for males, the proportion of people below minimum wage is significantly and positively associated with severity of lower body functional limitations.

Table 7 presents estimates of effect on existence of any lower body functional limitations, from multilevel models with both individual-level variables and community-level variables. We find no significant community level effects on existence of lower body functional limitations, for either females or males. In addition, the introduction of community-level variables does not considerably alter the coefficients estimated in analysis with only individual-level variables, except that the effect of variable “born in a high migration state” is reduced in size and is no longer significant, which may be due to that the communities characteristics explained the differences between the high migration states and the other states.

Table 8 reported results of the multi-level analysis of effect on severity of lower body functional limitations, of both individual-level and community-level variables. As the results show, none of the community-level variables is significantly associated with severity of lower body functional limitations, and the incorporation of community-level variables in multilevel models does not substantially change the associations between early life conditions and severity of lower body functional limitations.

In conclusion, we do not find any significant community level effect on lower body functional performance at old age, after controlling for individual characteristics, which may be due to the fact that the socioeconomic measures of community characteristics are highly correlated with individual socioeconomic status of residents. As Ginther et al. (2000) argued, the more individual and household characteristics are controlled for, the more likely neighborhood variables will lose the predictive power on health outcomes. In addition, the incorporation of community characteristics only slightly

alters the associations between early life conditions and lower body functional limitations at age 50 and older, with one exception that the association between "born in a high-migration state" and existence of any lower body functional limitations is reduced considerably and no longer significant.

Test on Coefficient Differences between Females and Males

Previous results have suggested some differences between males and females in association between early life conditions and lower body functional performance at ages 50 and above. For example, the association between working as professional or administrative personnel and severity of lower body functional limitations exhibits different patterns for males and females. Females who worked as professional or administrative personnel have more severe lower body functional limitations than females who worked in agriculture or forestry. In contrast, males who worked as professional or administrative personnel have less severe lower body functional limitations than males who worked in agriculture or forestry. To test whether these differences in coefficients (Model 4, without community-level variables) are statistically significant, we performed an equality test by the following statistic (Allison 1995; Lagakos 1978):

$$\frac{b_1 - b_2}{\sqrt{[s.e.(b_1)]^2 + [s.e.(b_2)]^2}}$$

Where s.e.(b_i) is the reported standard error of the coefficient b_i (subscript 1 refers to females, and subscript 2 refers to males). Under this null hypothesis, this statistic has an approximately standard normal distribution. We do not adjust degrees of freedom since the sample is large. As Table A2 in appendix shows, for existence of lower body functional limitations, there are significant differences between males and females in the coefficients for age, having more than 10 siblings, and arthritis, although the differences in magnitude are modest. Table A3 reports results for severity of lower body functional limitations. As shown, there are significant differences between females and males in the coefficients for income, education, and occupation of respondent. In summary, the results of the equality test suggest the need to run separate models for males and females.

Sensitivity Analysis

In the current analysis, all cases with missing values for explanatory variables are excluded from the sample. Is this deletion likely to bias the results? To test the robustness of our results, we estimate Model 4 without the variable of mother's education that has the most serious missing data problem (which means that no case is excluded from the sample because of missing data on mother's education). The results (not included) suggest that our estimates are robust (at least for variables other than mother's education) to missing data on explanatory variables.

Conclusions and Discussion

Although considerable literature has addressed social disparities in adult functional performance, little is known about the role of early life conditions in functional disparities. Our study is among the first to examine the relationship between early life conditions and lower body functional performance later in life. It suggests that lower body functional limitations in late life are significantly associated with early life conditions, and this association may operate partly through such "chains" as adult SES, smoking behavior, and possibly chronic diseases (Kuh et al. 2003; Power and Hertzman 1997), as hypothesized in the theoretical framework (Figure 1). Our study also suggests that existence of lower body functional limitations and severity of these limitations may be differently associated with early life conditions, and the associations may be differently mediated by adult characteristics.

In general, children who lived in houses without a sanitary facility such as a toilet, children whose families needed financial help, and children who often had the experience of being hungry in early life had worse lower body functional performance in adulthood than others. These findings are consistent with previous studies. For example, hunger is found to have an adverse impact on children's mental and physical health (Weinreb et al. 2002). Moreover, it was reported that malnourished children have a high risk of physical underdevelopment and disability in adulthood (Smith and Haddad 2000).

Father's occupation is also a significant predictor of lower body functional limitations at old age. Having a father who worked as professional and administrative personnel is significantly associated with good functional performance in late life in

bivariate analysis. However, this association is reduced and is no longer significant after adjustment for other measures of early life conditions in multivariate analysis, which suggests that the protective effect of father's prestigious job may come mainly from material advantages, such as nutritional provisions for the children and sanitary facilities inside the house. In contrast, the association between having no father (guardian) in early life and higher risk of adult lower body functional limitations remains significant after controlling for other proxies of early life conditions, which suggests that father's absence in early life may result in not only economic hardship, but also other adverse experiences for the children. For example, father's absence may lead to children's failure to learn how to acquire and maintain healthy conditions during the process of socialization (Dufour and Bouchard 2003).

It is widely believed that maternal education improves children's health (Schultz 1993). Our study provides positive evidence for beneficial effects of maternal education on functional performance of the children in their adult life. Regarding the mechanisms, maternal education may operate through its association with family socioeconomic status (Desai and Alva 1998). Mother's education at junior high level or above predicts lower likelihood of reporting any lower body functional limitations in adulthood in the bivariate analysis (results not shown), and the predictive power disappears after controlling for other proxies of family conditions, which is consistent with findings that mother's education impacts children's health primarily through its association with improved family income, and high level of education helps promote women's labor market participation and further contributes to family income (Ahmed and Iqbal 2006). In addition, maternal education may also affect adult lower body functional performance through its associations with adult characteristics of respondents. In our study, mother's education exhibits a significant association with severity of lower body functional performance in adulthood for females; the significance of this association diminished after adjustment of adult characteristics.

Regarding the possible mechanisms underlying the associations between early life conditions (including childhood health) and adulthood lower body functional limitations, the findings from our study are very suggestive. Health behaviors may play a role in connecting family background and adult functional performance. Our additional analysis

(results not shown) suggests that “had toilet inside house before age 10” predicts significantly lower possibility of early smoking (measured by “started smoking before age 16”), which itself is associated with lower risk of having any lower body functional limitations. In addition, the chronic diseases and symptom also mediate the associations between childhood health and having any lower body functional limitations. We are cautious to make an inference that chronic diseases are the paths through which childhood health leads to adult functional limitations. First, childhood health and chronics diseases may be caused by some common risk factors, such as congenital defect. Second, no information is available on how these chronic diseases included in this study and functional limitations were developed along life span, i.e., whether these chronic diseases preceded functional limitations or vice verse, or they occurred simultaneously. However, there is ample evidence from previous studies to suggest the higher probability that some chronic diseases precede functional limitations. For example, arthritis limits functional ability. On the other hand, we also acknowledge the possibility that functional limitations and the consequent inactivity may cause problems of being overweight and obese, which in turn can increase the risk of some disease such as diabetes.

Our study also suggests that the associations between early life conditions and adult lower body functional limitations and the underlying mechanisms may differ by gender and measures of lower body functional limitations. For example, respondent’s education plays a different role in predicting existence of any lower body functional limitations and severity of such limitations for females. The effect of education on existence of any lower body functional limitations shrinks and is no longer significant after controlling for other adult characteristics. In contrast, education exhibits independent effect on severity of lower body functional limitations, net of other adult characteristics. We speculate that education may work particularly well after the onset of any lower body functional limitation. Specifically, upon the awareness of functional limitations, educated people may be more likely than the illiterate to take actions against further aggravation of functional limitations, by resorting to medical suggestion and taking advantage of rehabilitation facilities. However, such an independent effect of education seems not to be applicable for males. The gender difference in education effect is also reported in research on chronic diseases (Wu et al. 2004). One explanation is that

compared to females, males have stronger social ties and more access to medical resources to maintain healthy function, which may dwarf the protective effect of education.

Our study has several limitations. First, all the measurements of early life conditions are based on retrospective information, and the recall errors may give rise to bias estimates. For example, people currently having functional limitations may be more likely to recall their health problems in childhood than others, which leads to overestimate of the association between health problems in childhood and adult lower body functional limitations. Second, we exclude respondents in proxy interview because no information on functional limitations has been collected from them. Since the proxy respondents are older on average and may have more severe functional limitations, excluding them from the sample may bias the estimates. Third, our study is limited to examining associations rather than establishing causality. In fact, without additional information, it is hard to answer questions such as whether childhood health leads to chronic illness and then lower body functional limitations later in life, or whether some unobserved common factors, such as genetics, cause childhood health problem, chronic illness and lower body functional limitations later in life.

Despite the limitations discussed above, the findings from this study are suggestive. First, there might be a considerable increase in disability prevalence as population ages rapidly. Our results show that age is a significant predictor of adult lower body functional limitations even after controlling for a variety of covariates. For males aged 50 and older, each ten years increase in age doubles the odds of having any lower body functional limitations. This deterioration with age appears to be slower for females aged 50 and older, with each fourteen years increase in age doubling the odds of having any lower body functional limitation. Second, any effort to prevent or minimize the functional disability should be combined with a practical anti-poverty program for children. As indicated in this study, Mexicans who experienced hunger in childhood have significantly more severe lower body functional limitations in adulthood than others, which suggests that social assistance programs, such as food assistance, may help children born into low-income families maintain healthy function in adulthood. Unfortunately, it is estimated that over 50% of children in the developing countries are

still living in poverty, in terms of deprivation of food, water, and sanitation, as well as lack of access to education and medical services (Gordon et al. 2003). This deprived childhood might pose a substantial risk of lower body functional limitations in adult life. Finally, enhancing female children's education may benefit their health. Our study suggests that females' education at higher level is associated with less severe functional limitations at age 50 and older, after adjustment of other adult characteristics such as income and occupation. Therefore, eliminating the prevailing gender discrimination against girls in education may significantly improve women's health, including physical functioning.

Figure 1 Mechanisms Underlying the Associations between Early Life Conditions and Adult Functional Limitations

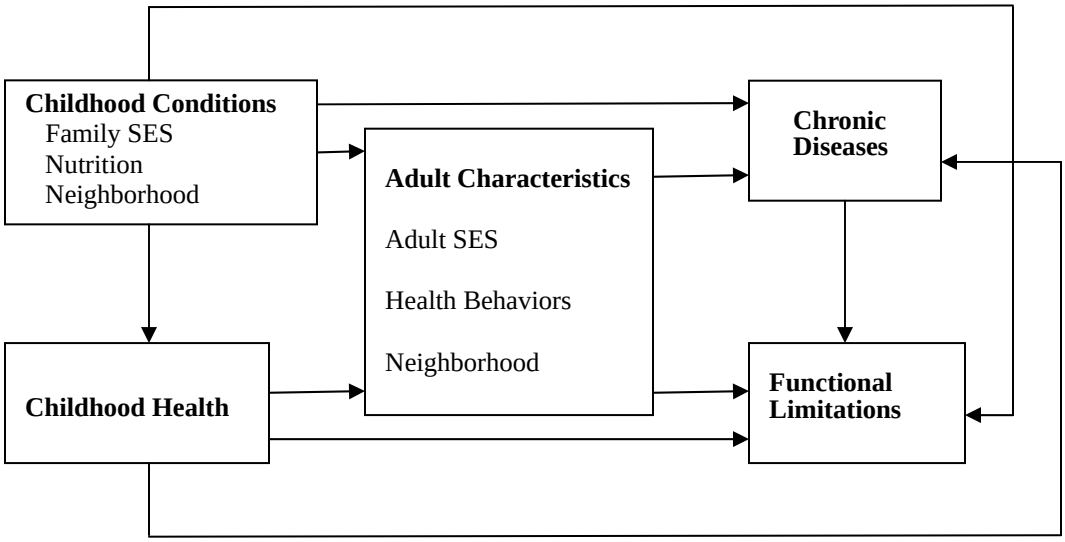
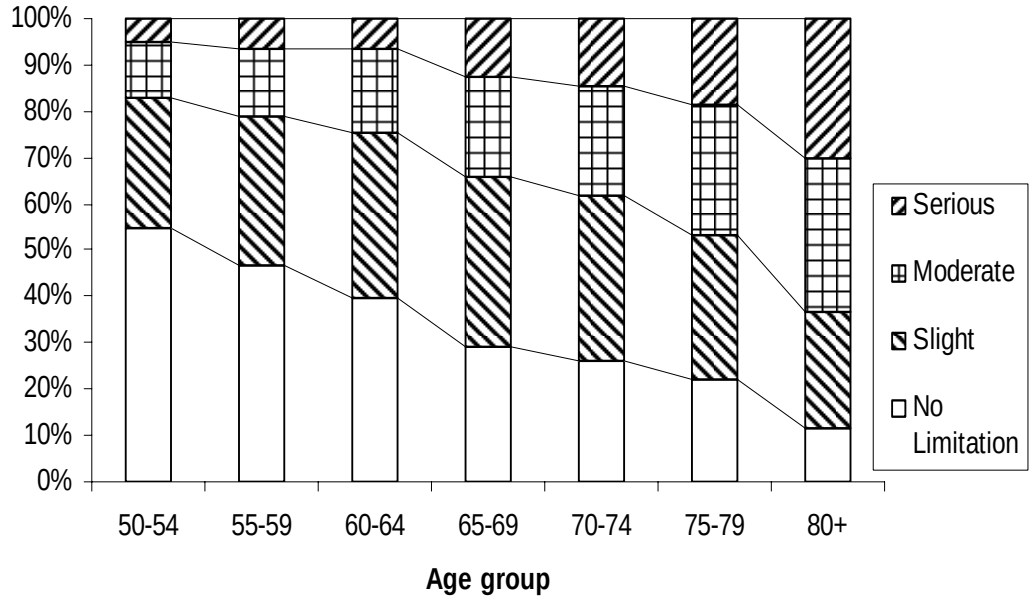
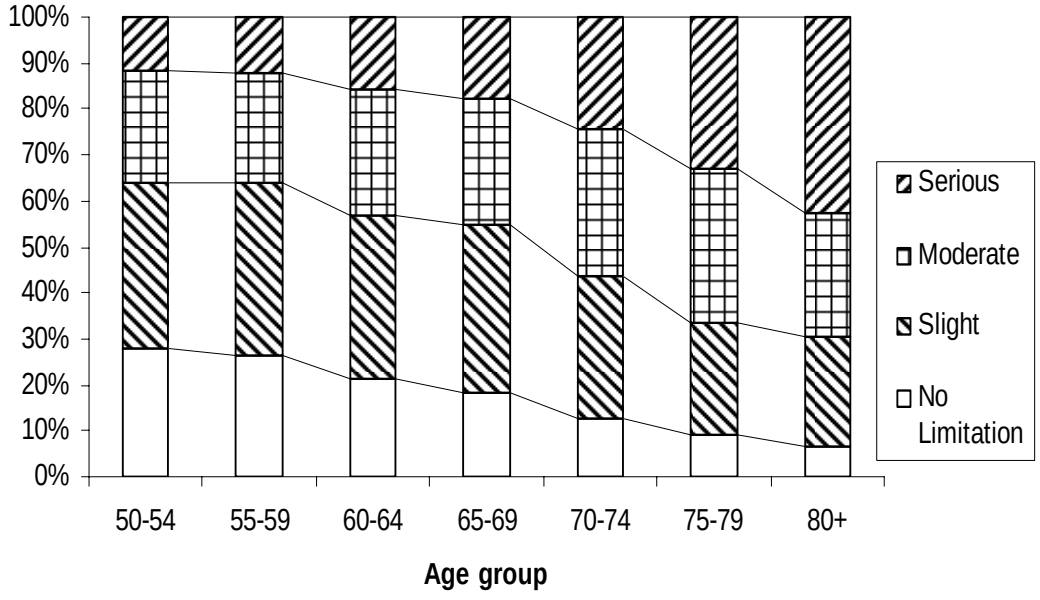


Figure 2.1 Lower Body Functional Limitations among Males by Age Group



Data source: The Mexican Health and Aging Study (MHAS), the 2003 wave

Figure 2.2 Lower Body Functional Limitations among Females by Age Group



Data source: The Mexican Health and Aging Study (MHAS), the 2003 wave

Table 1.1 Characteristics of Mexicans[1] Aged 50 and Older in 2003 Mexican Health and Aging Study

Characteristics	Males N=4,581	%	Females N=6,158	%
Functional limitations (lower body scale[2])				
No limitation	1,610	35.15	1,253	20.35
Slight limitation	1,496	32.66	2,053	33.34
Moderate limitation	917	20.02	1,657	26.91
Serious limitation	535	11.68	1,153	18.72
Missing	23	0.50	42	0.68
Age				
Mean	64.7		63.3	
(Std. Dev.)	(9.3)		(9.4)	
Early Life Conditions				
Born in high migration state				
Yes	1,540	33.62	2,062	33.48
No	3,041	66.38	4,096	66.52
Had toilet inside house before age 10				
Yes	1,182	25.82	1,774	28.81
No	3,389	73.98	4,363	70.85
Missing	10	0.22	21	0.34
Often went to bed hungry before age 10				
Yes	1,594	34.80	1,882	30.56
No	2,942	64.22	4,206	68.30
Missing	45	0.99	70	1.14
Family received financial help before age 10				
Yes	420	9.17	513	8.33
No	4,102	89.54	5,578	90.58
Missing	59	1.28	67	1.08
Had serious health Problem before age 10				
Yes	500	10.91	676	10.98
No	4,007	87.47	5,410	87.85
Missing	74	1.62	72	1.17
Residence when living with parents				
Urban	1,772	38.68	2,481	40.29
Rural	2,776	60.60	3,630	58.95
Missing	33	0.72	47	0.76
Father's occupation				
Agriculture	2,622	57.24	3,385	54.97
Construction	628	13.71	820	13.32
Gardening/maintenance/service/store/hotel	731	15.96	1,062	17.25
In an office/Professional	131	2.86	176	2.86
Other[3] or have no father/guardian	386	8.43	570	9.26
Missing	83	1.81	145	2.35
Mother's education				
None	2,305	50.32	3,038	49.33
Some elementary	1,209	26.39	1,729	28.08
Completed elementary	425	9.28	583	9.47
Primary high and above	175	3.82	246	3.99
Missing	467	10.19	562	9.13
Siblings born alive				
0	86	1.88	126	2.05
1-3	781	17.05	1,023	16.61
4-6	1,619	35.34	2,064	33.52
7-9	1,259	27.48	1,691	27.46
10+	799	17.44	1,211	19.67
Missing	37	0.81	43	0.70

(Continued on next page)

1 Proxy respondents have been excluded
2 Lower body scales are based on 8 Nagi items measuring lower body functional limitations
3 Other refers to childcare, works not specified in questionnaire and those who did not work
Data source: The Mexican Health and Aging Study (MHAS), the 2001 wave (respondent's employment, education, and whether had serious health problems before age 10) and 2003 wave (other variables)

Table 1.1 Continued

Characteristics	Males N=4,581	%	Females N=6,158	%
Adult Characteristics				
Education of respondent				
None	975	21.28	1,613	26.19
Some primary	1,623	35.43	2,195	35.64
Complete primary	904	19.73	1,120	18.19
Junior high	350	7.64	332	5.39
High school and above	725	15.83	895	14.53
Missing	4	0.09	3	0.05
Respondent's occupation				
Professional or administrative personnel	693	15.13	510	8.28
Workers in agriculture/forestry	1,273	27.79	391	6.35
Industrial worker	1,298	28.33	741	12.03
Office staff	524	11.44	1,093	17.75
Service worker	233	5.09	1,390	22.57
Other[1]	560	12.22	2,033	33.01
Individual income (Mexican Peso)				
No income or negative income	459	10.07	1,314	21.33
25% Q1 cutoff value (of positive income)[2]	1,350.00		750.00	
Median cutoff value (of positive income)[2]	2,700.00		1,666.67	
75% Q3 cutoff value (of positive income)[2]	5,129.00		3,925.85	
Household assets (Mexican Peso)				
No assets or negative assets	224	4.91	471	7.65
25% Q1 cutoff value (of positive assets)[2]	115,000		101,000	
Median cutoff value (of positive assets)[2]	295,000		273,123	
75% Q3cutoff value (of positive assets)[2]	595,000		550,000	
Smoking behavior				
Never	1,543	33.68	4,712	76.52
Started smoking before age 16	1,251	27.31	327	5.31
Started smoking at age 16 or older	1,756	38.33	1,096	17.80
Missing	31	0.68	23	0.37
Married or in consensual union				
Yes	3,774	82.38	3,607	58.57
No	807	17.62	2,551	41.43
Chronic Health Conditions				
Had diabetes				
Yes	689	15.04	1,123	18.24
No	3,871	84.50	5,011	81.37
Missing	21	0.46	24	0.39
Had arthritis				
Yes	631	13.77	1,375	22.33
No	3,941	86.03	4,773	77.51
Missing	9	0.20	10	0.16
Often suffer from pain				
Yes	1,505	32.85	2,767	44.93
No	3,074	67.10	3,391	55.07
Missing	2	0.04	0	0
Time of moving in current location				
Always lived here or moved before age 15	2,149	46.91	2,845	46.20
After age 15, before age 50	2,037	44.47	2,843	46.17
After age 50	375	8.19	435	7.06
Missing	20	0.44	36	0.57

1 Other refers to drivers, safety personnel, and other not specified or never had a paid or unpaid job.
2 The value is reported by gender. 25% Q1 cutoff value means 25% of the respondents who had positive income/assets had income/assets below this value.
Data source: The Mexican Health and Aging Study (MHAS), the 2001 wave (respondent's employment, education, and whether had serious health problems before age 10) and 2003 wave (other variables)

Table 1.2 Community Characteristics for Respondents Aged 50+ in 2003 Mexican Health and Aging Study

Characteristics	Males N=4,581	%	Females N=6,158	%
Number of doctor per 10,000 resident				
0-13	1,487	32.46	1,892	30.72
13-23	1,558	34.01	2,128	34.56
24+	1,432	31.26	2,024	32.87
Missing	104	2.27	114	1.85
15+ with higher education (proportion)				
[0-0.28]	1,585	34.60	1,939	31.49
[0.28-0.41]	1,476	32.22	2,014	32.71
[0.41-1]	1,445	31.54	2,125	34.51
Missing	75	1.64	80	1.30
Below minimum wage (proportion)				
[0-0.07)	1,464	31.96	1,998	32.45
[0.07-0.12]	1,432	31.26	1,964	31.89
[0.12-1]	1,609	35.12	2,114	34.33
Missing	76	1.66	82	1.33

Data sources: The 2000 Mexican Census of Population and Dwelling, and the 2002 Directory of Public Health Sector Facilities

Table 2.1 Odds Ratios for Existence of Any Lower Body Functional Limitations For Male Mexicans Aged 50+, Based on Binary Logit Models (N=3,676)

Variables	Model 1	Model 2	Model 3	Model 4
Age	1.070**	1.070**	1.069**	1.069**
Early Life Conditions				
Born in high migration state	0.793**	0.788**	0.778**	0.782**
Had toilet inside house before age 10	0.658**	0.662**	0.716**	0.752**
Often went to bed hungry before age 10	1.203*	1.201*	1.159^{+}	1.038
Family received financial help before age 10	1.542**	1.534**	1.544**	1.458**
Lived in urban area with parents	1.064**	1.059	1.079	1.060
Father's occupation *(Agriculture)*				
Construction	0.903	0.902	0.884	0.877
Gardening/maintenance/service/store/hotel	0.973	0.970	0.957	0.970
In an office/Professional	1.167	1.158	1.336	1.347
Other[1] or have no father/ guardian	1.304^{+}	1.301^{+}	1.353*	1.289^{+}
Mother's education *(None)*				
Some elementary	0.972	0.969	1.041	1.021
Completed elementary	0.942	0.941	1.061	1.042
Primary high and above	0.745	0.749	0.914	0.877
Siblings born alive (1-3)				
0	1.014	1.010	0.982	0.958
4-6	1.162	1.163	1.153	1.156
7-9	1.231^{+}	1.234^{+}	1.216^{+}	1.180
10+	1.357**	1.353*	1.325*	1.337*
Childhood Heath				
Had serious health problems before age 10		1.214^{+}	1.242^{+}	1.129
Adult Characteristics				
Education of respondent *(None)*				
Some primary			1.024	1.063
Complete primary			1.122	1.140
Junior high			1.199	1.365^{+}
High school and above			0.782	0.878
Respondent's occupation *(Agriculture/forestry)*				
Professional or administrative personnel			0.910	0.964
Industrial worker			0.845	0.866
Office staff			1.100	1.151
Service worker			0.834	0.941
Other[2]			1.045	1.070
Individual income (*Below 25%Q*)				
Have no or negative income			0.935	0.915
Above 25%Q, below median			0.900	0.932
Above median, below 75%Q			0.850	0.895
Above 75%Q			0.821	0.850
Household assets (*Below 25%Q*)				
Have no or negative assets			1.370	1.297
Above 25%Q, below median			1.165	1.190
Above median, below 75%Q			1.110	1.116
Above 75%Q			0.854	0.853
Married or in consensual union			1.100*	1.066*
Smoking behaviors *(Never)*				
Started smoking before age 16			1.569**	1.494**
Started smoking at age 16 or older			1.225*	1.181^{+}
Chronic Health Conditions				
Had diabetes				1.590**
Had arthritis				2.199**
Often suffer from pain				2.503**
-2 Log Likelihood				
Intercept only	4833.6	----	----	----
Intercept and Covariates	4482.9	4480.1	4416.1	4211.6

$^{+}$ p<0.1;* p<0.05; **p<0.01

1 Other refers to childcare, works not specified in questionnaire and those who did not work

2 Other refers to drivers, safety personnel, and other not specified or never had a paid or unpaid job.

Data source: Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave.

Table 2.2 Odds Ratios for Existence of Any Lower Body Functional Limitations for Female Mexicans Aged 50+, Based on Binary Logit Models (N=5,034)

Variables	Model 1	Model 2	Model 3	Model 4
Age	1.052**	1.052**	1.054**	1.053**
Early Life Conditions				
Born in high migration state	0.760**	0.758**	0.738**	0.698**
Had toilet inside house before age 10	0.662**	0.659**	0.729**	0.783*
Often went to bed hungry before age 10	1.185^{+}	1.179^{+}	1.119	1.012
Family received financial help before age 10	1.680**	1.681**	1.678**	1.608**
Lived in urban area with parents	0.897	0.898	0.952	0.912
Father's occupation *(Agriculture)*				
Construction	1.060	1.061	1.081	1.030
Gardening/maintenance/service/store/hotel	0.976	0.975	1.023	1.019
In an office/professional	0.855	0.851	0.981	0.933
Other[1] or have no father/ guardian	1.536**	1.533**	1.599**	1.581**
Mother's education *(None)*				
Some elementary	0.999	0.999	1.084	1.053
Completed elementary	0.885	0.887	1.038	1.074
Primary high and above	0.769	0.764	0.977	0.943
Siblings born alive (1-3)				
0	0.672	0.680	0.650	0.625^{+}
4-6	1.100	1.097	1.076	1.067
7-9	1.200	1.200	1.171	1.133
10+	1.056	1.054	1.014	0.928
Childhood Heath				
Had serious health problems before age 10		1.282*	1.302*	1.152
Adult Characteristics				
Education of respondent *(None)*				
Some primary			1.163	1.193
Complete primary			1.056	1.176
Junior high			0.826	0.930
High school and above			0.772	0.902
Respondent's occupation *(Agriculture/forestry)*				
Professional or administrative personnel			0.635*	0.563*
Industrial worker			0.701^{+}	0.607*
Office staff			0.770	0.717
Service worker			0.969	0.893
Other[2]			0.804	0.776
Individual income (*Below 25%Q*)				
Have no or negative income			0.867	0.915
Above 25%Q, below median			0.916	0.931
Above median, below 75%Q			0.888	0.898
Above 75%Q			0.899	0.927
Household assets (*Below 25%Q*)				
Have no or negative assets			0.985	0.954
Above 25%Q, below median			1.081	1.102
Above median, below 75%Q			0.904	0.922
Above 75%Q			0.916	0.955
Married or in consensual union			1.145	1.116
Smoking behaviors *(Never)*				
Started smoking before age 16			1.513*	1.627**
Started smoking at age 16 or older			1.277*	1.271*
Chronic Health Conditions				
Had diabetes				1.854**
Had arthritis				1.530**
Often suffer from pain				3.029**
-2 Log Likelihood				
Intercept only	5147.5			
Intercept and covariates	4884.1	4879.6	4826.7	4551.7

$^{+}$ p<0.1;* p<0.05; **p<0.01

1 Other refers to childcare, works not specified in questionnaire and those who did not work

2 Other refers to drivers, safety personnel, and other not specified or never had a paid or unpaid job.

Data source: Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave.

Table 3.1 Odds Ratios for Severity of Lower Body Functional Limitations (Low to High) for the Male Mexicans Aged 50+ Among Those Who Had at Least One Functional Limitation, Based on Cumulative Logit Models (N=2,328)

Variables	Model 1	Model 2	Model 3	Model 4
Age	1.047**	1.047**	1.047**	1.051**
Early Life Conditions				
Born in high migration state	1.065	1.057	1.042	1.029
Had toilet inside house before age 10	0.878	0.884	0.894	0.918
Often went to bed hungry before age 10	1.642**	1.639**	1.600**	1.375**
Family received financial help before age 10	1.078	1.062	1.121	1.056
Lived in urban area with parents	0.898	0.887	0.892	0.877
Father's occupation *(Agriculture)*				
Construction	1.040	1.044	1.050	1.080
Gardening/maintenance/service/store/hotel	0.892	0.892	0.912	0.976
In an office/Professional	0.774	0.771	0.875	0.880
Other[1] or have no father/ guardian	1.082	1.076	1.166	1.136
Mother's education *(None)*				
Some elementary	1.023	1.016	1.032	1.017
Completed elementary	1.077	1.074	1.135	1.059
Primary high and above	0.971	0.975	1.036	0.955
Siblings born alive (1-3)				
0	1.326	1.350	1.435	1.484
4-6	1.000	1.001	1.049	1.110
7-9	1.171	1.176	1.215	1.199
10+	1.113	1.104	1.137	1.173
Childhood Heath				
Had serious health problems before age 10		1.342*	1.374**	1.255+
Adult Characteristics				
Education of respondent *(None)*				
Some primary			0.939	0.947
Complete primary			1.040	1.077
Junior high			1.016	1.154
High school and above			1.036	1.156
Respondent's occupation *(Agriculture/forestry)*				
Professional or administrative personnel			0.672**	0.742+
Industrial worker			0.928	0.995
Office staff			0.902	0.973
Service worker			0.692+	0.806
Other[2]			0.884	0.954
Individual income (*Below 25%Q*)				
Have no or negative income			1.298+	1.222
Above 25%Q, below median			0.933	0.924
Above median, below 75%Q			0.676**	0.659**
Above 75%Q			0.810	0.763+
Household assets (*Below 25%Q*)				
Have no or negative assets			1.050	1.004
Above 25%Q, below median			0.866	0.905
Above median, below 75%Q			1.197	1.232+
Above 75%Q			1.069	1.118
Married or in consensual union			1.205+	1.237+
Smoking behaviors *(Never)*				
Started smoking before age 16			1.199+	1.132
Started smoking at age 16 or older			1.298**	1.253*
Chronic Health Conditions				
Had diabetes				1.505**
Had arthritis				2.319**
Often suffer from pain				3.094**
-2 Log Likelihood				
Intercept only	4681.9			
Intercept and covariates	4505.7	4500.0	4452.0	4171.0

+p<0.1;* p<0.05; **p<0.01

1 Other refers to childcare, works not specified in questionnaire and those who did not work

2 Other refers to drivers, safety personnel, and other not specified or never had a paid or unpaid job.

Data source: Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave.

Table 3.2 Odds Ratios for Severity of Lower Body Functional Limitations (Low to High) for the Female Mexicans Aged 50+ Among Those Who Had at Least One Functional Limitation, Based on Cumulative Logit Models (N=3,987)

Variables	Model 1	Model 2	Model 3	Model 4
Age	1.045**	1.044**	1.042**	1.045**
Early Life Conditions				
Born in high migration state	1.100	1.099	1.086	1.056
Had toilet inside house before age 10	0.882	0.877	0.932	1.000
Often went to bed hungry before age 10	1.457**	1.449**	1.387**	1.272**
Family received financial help before age 10	1.218^{+}	1.213^{+}	1.203^{+}	1.204^{+}
Lived in urban area with parents	1.028	1.028	1.086	1.048
Father's occupation *(Agriculture)*				
Construction	1.188^{+}	1.193^{+}	1.208^{+}	1.159
Gardening/maintenance/service/store/hotel	1.206*	1.206*	1.281**	1.294**
In an office/Professional	1.010	1.009	1.105	1.067
Other[1] or have no father/ guardian	1.146	1.142	1.172	1.208^{+}
Mother's education *(None)*				
Some elementary	0.869*	0.871*	0.940	0.927
Completed elementary	0.877	0.874	1.001	1.049
Primary high and above	0.880	0.867	1.027	1.079
Siblings born alive (1-3)				
0	0.977	0.996	0.973	0.845
4-6	1.029	1.024	1.015	0.960
7-9	1.166	1.163	1.146	1.116
10+	1.229*	1.222^{+}	1.206^{+}	1.079
Childhood Heath				
Had serious health problems before age 10		1.304**	1.315**	1.186^{+}
Adult Characteristics				
Education of respondent *(None)*				
Some primary			0.955	0.975
Complete primary			0.714**	0.733**
Junior high			0.638**	0.714*
High school and above			0.561**	0.583**
Respondent's occupation *(Agriculture/forestry)*				
Professional or administrative personnel			1.484*	1.412^{+}
Industrial worker			1.017	0.921
Office staff			1.081	1.037
Service worker			1.028	0.964
Other[2]			1.056	1.056
Individual income (*Below 25%Q*)				
Have no or negative income			1.128	1.211
Above 25%Q, below median			0.934	0.943
Above median, below 75%Q			1.068	1.119
Above 75%Q			0.927	0.952
Household assets (*Below 25%Q*)				
Have no or negative assets			1.043	0.960*
Above 25%Q, below median			0.883	0.902
Above median, below 75%Q			1.031	1.056
Above 75%Q			0.882	0.912
Married or in consensual union			1.031*	1.012
Smoking behaviors *(never)*				
Started smoking before age 16			1.057	1.133
Started smoking at age 16 or older			1.047	1.031
Chronic Health Conditions				
Had diabetes				1.554**
Had arthritis				2.055**
Often suffer from pain				3.090**
-2 Log Likelihood				
Intercept only	8501.5	---	---	---
Intercept and Covariates	8255.0	8246.6	8207.1	7681.7

$^{+}$p<0.1;* p<0.05; **p<0.01

1 Other refers to childcare, works not specified in questionnaire and those who did not work

2 Other refers to drivers, safety personnel, and other not specified or never had a paid or unpaid job.

Data source: Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave.

Table 4 Interclass Correlations Based on Empty Models with Neither Individual-level Nor Community-level Covariates Among Mexicans Aged 50+ in 2003

Random effect	Models for Existence of Any Functional Limitations		Models for Severity of Lower body functional limitations	
	Females	Males	Females	Males
Community-level variance component	0.323	0.253	0.232	0.287
Individual-level variance component	3.289	3.289	3.289	3.289
Interclass correlations	0.09	0.08	0.07	0.02

Data sources: The Mexican Health and Aging Study, the 2000 Mexican Census of Population and Dwelling, and the 2002 Directory of Public Health Sector Facilities

Table 5 Odds Ratios for Effect of Community-level Factors on Existence of Any Lower Body Functional Limitations for Mexicans Aged 50+ in MHAS

Variables	Females (N=5,034)		Males (N=3,676)	
	Bivariate	Multivariate[1]	Bivariate	Multivariate[1]
Number of doctor per 10,000 residents	0.995	0.997	0.995	0.999
15+ with higher education (proportion)	0.657	0.765	0.319**	0.360**
Below minimum wage (proportion)	1.368	1.092	2.311*	1.289

* p<0.05; **p<0.01

[1] Controlling for community-level variables simultaneously

Data sources: The Mexican Health and Aging Study, the 2000 Mexican Census of Population and Dwelling, and the 2002 Directory of Public Health Sector Facilities

Table 6 Odds Ratios for Effect of Community-level Factors on Severity of Lower Body Functional Limitations for Mexicans Aged 50+ Among Those Who Reported at Least One Lower Body Functional Limitation in MHAS

Variables	Females (N=3,987)		Males (N=2,328)	
	Bivariate	Multivariate[1]	Bivariate	Multivariate[1]
Number of doctor per 10,000 residents	1.000	1.002	1.000	1.003
15+ with higher education (proportion)	0.520*	0.478*	0.357**	0.455*
Below minimum wage (proportion)	1.463	0.974	3.757**	2.407*

* p<0.05; **p<0.01

[1] Controlling for community-level variables simultaneously

Data sources: The Mexican Health and Aging Study, the 2000 Mexican Census of Population and Dwelling, and the 2002 Directory of Public Health Sector Facilities

Table 7 Odds Ratios for Existence of Any Lower Body Functional Limitations Among Mexicans Aged 50+

Explanatory Variables	Males (n=3,676)	Females (n=5,034)
Individual-Level Variables		
Age	1.070**	1.053**
Born in high migration state	0.956	0.901
Had toilet inside house before age 10	0.769*	0.803*
Often went to bed hungry before age 10	1.037	1.077
Family received financial help before age 10	1.404*	1.610**
Lived in urban area with parents	1.095	0.896
Father's occupation *(Agriculture)*		
Construction	0.878	1.036
Gardening/maintenance/service/store/hotel	0.990	1.040
In an office/Professional	1.479 +	0.980
Other[1] or have no father/ guardian	1.257	1.451**
Mother's education *(None)*		
Some elementary	0.996	1.032
Completed elementary	0.984	1.074
Primary high and above	0.835	0.940
Siblings born alive (1-3)		
0	0.925	0.694
4-6	1.141	1.060
7-9	1.140	1.094
10+	1.257 +	0.902
Before age 10, had serious health problem	1.154	1.245+
Education of respondent *(None)*		
Some primary	1.068	1.147
Complete primary	1.184	1.142
Junior high	1.410 +	0.898
High school and above	0.909	0.900
Respondent's occupation *(Agriculture/forestry)*		
Professional or administrative personnel	1.029	0.553*
Industrial worker	0.923	0.601*
Office staff	1.242	0.701+
Service worker	1.037	0.893
Other[2]	1.143	0.752
Individual income (*Below 25%Q*)		
Have no or negative income	0.936	0.932
Above 25%Q, below median	0.917	0.929
Above median, below 75%Q	0.877	0.867
Above 75%Q	0.834	0.904
Household assets (*Below 25%Q*)		
Have no or negative assets	1.301	0.927
Above 25%Q, below median	1.169	1.048
Above median, below 75%Q	1.103	0.892
Above 75%Q	0.842	0.978
Married or in consensual union	1.073	1.101
Smoking behaviors *(Never)*		
Started smoking before age 16	1.453**	1.600**
Started smoking at age 16 or older	1.160	1.239*
The time of moving in current location (*Always lived here or before 15 years old)*		
After 15, before 50 years old	1.099	0.906
After 50 years old	1.152	1.016
Had diabetes	1.603**	1.757**
Had arthritis	2.260**	1.550**
Often suffer from pain	2.535**	3.134**
Community-level Variables		
Number of doctor per 10,000 residents	0.997	0.995
15+ with higher education (proportion)	0.559	1.853
Below minimum wage (proportion)	0.819	0.620

+p<0.1;* p<0.05; **p<0.01

Data source: The Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave, the 2000 Mexican Census of Population and Dwelling, and the 2002 Directory of Public Health Sector Facilities

Table 8 Odds Ratios for Severity of Lower Body Functional Limitations (Low to High) Among Mexicans Aged 50+ Who Had at Least One Lower Body Functional Limitation in 2003

Explanatory Variables	Males (n=2,328)	Females (n=3,987)
Individual-Level Variables		
Age	1.052**	1.048**
Born in high migration state	1.049	1.008
Had toilet inside house before age 10	0.953	1.010
Often went to bed hungry before age 10	1.358**	1.253**
Family received financial help before age 10	1.060	1.228
Lived in urban area with parents	0.855	1.058
Father's occupation *(Agriculture)*		
Construction	1.073	1.151
Gardening/maintenance/service/store/hotel	0.980	1.306**
In an office/Professional	0.852	1.184
Other[1] or have no father/ guardian	1.110	1.126
Mother's education *(None)*		
Some elementary	1.008	0.921
Completed elementary	1.042	1.010
Primary high and above	0.942	0.992
Siblings born alive (1-3)		
0	1.486	0.853
4-6	1.105	0.931
7-9	1.172	1.083
10+	1.160	1.062
Before age 10, had serious health problem	1.247+	1.192+
Education of respondent *(None)*		
Some primary	0.936	0.958
Complete primary	1.065	0.713**
Junior high	1.119	0.674*
High school and above	1.143	0.563**
Respondent's occupation *(Agriculture/forestry)*		
Professional or administrative personnel	0.754	1.422+
Industrial worker	1.015	0.993
Office staff	0.958	1.060
Service worker	0.820	0.975
Other[2]	0.966	1.052
Individual Income (*Below 25%Q*)		
Have no or negative income	1.205	1.177+
Above 25%Q, below median	0.925	0.966
Above median, below 75%Q	0.664**	1.103
Above 75%Q	0.745*	0.950
Household Assets (*Below 25%Q*)		
Have no or negative assets	1.160	0.945
Above 25%Q, below median	0.902	0.916
Above median, below 75%Q	1.214	1.053
Above 75%Q	1.111	0.905
Married or in consensual union	1.242	1.025
Smoking behaviors *(Never)*		
Started smoking before age 16	1.132	1.119
Started smoking at age 16 or older	1.243*	1.023
The time of moving in current location (*Always lived here or before age 15)*		
After age 15, before age 50	0.901	0.920
After age 50	0.865	0.813
Had diabetes	1.500**	1.583**
Had arthritis	2.325**	2.041**
Often suffer from pain	3.120**	3.162**
Community-Level Variables		
Number of doctor per 10,000 resident	1.003	0.997
15+ with higher education (proportion)	0.819	0.802
Below minimum wage (proportion)	0.674	0.604

+p<0.1;* p<0.05; **p<0.01

Data source: The Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave, the 2000 Mexican Census of Population and Dwelling, and the 2002 Directory of Public Health Sector Facilities

APPENDIX

Table A1. Lower Body Functional Limitations Among Mexicans Aged 50+ Who Received Direct Interview (N=10,739)

Nagi Item	Having trouble[1]	No trouble	Missing[2]
Running a mile	7,067	3,614	58
Walking several blocks	2,767	7,971	1
Walking one block	1,291	9,447	1
Climbing several stairs	5,187	5,498	54
Climbing one stair	2,447	8,273	19
Sitting for two hours	1,728	9,011	0
Getting from chair after sitting for long period	2, 603	8,135	1
Stooping, kneeling, or crouching (h8)	3,731	7,005	3

[1] The category of "having trouble" also includes "can't do" and "does not do"

[2] Missing refers to "do not know" and refused to answer.

Data source: The second wave of Mexican Health and Aging Study (MHAS) in 2003

Table A2 Test for the Equality of Coefficients of Predictors of Existence of Lower Body Functional Limitations Between Male and Female Mexicans Among Those Who Aged 50+ in 2003

Explanatory Variables	Females		Males		Test statistics [a]
	b_1	$s.e.(b_1)$	b_2	$s.e.(b_2)$	$\frac{b_1-b_2}{\sqrt{[s.e.(b_1)]^2+[s.e.(b_2)]^2}}$
Age	0.051	0.005	0.067	0.005	2.176*
Born in high migration state	-0.359	0.079	-0.246	0.081	0.983
Before age 10, had toilet inside house	-0.245	0.097	-0.285	0.101	-0.309
Before age 10, often went to bed hungry	0.011	0.093	0.038	0.086	0.194
Before age 10, family received financial help	0.475	0.155	0.377	0.137	-0.441
Lived in urban area with parents	-0.092	0.097	0.059	0.100	1.086
Father's occupation *(Agriculture)*					
Construction	0.030	0.123	-0.131	0.124	-0.914
Gardening/maintenance/service/store/hotel	0.019	0.113	-0.030	0.121	-0.268
In an office/Professional	-0.070	0.214	0.298	0.239	1.138
Other[1] or have no father/ guardian	0.458	0.150	0.254	0.151	-0.969
Mother's education *(None)*					
Some elementary	0.052	0.091	0.020	0.092	-0.214
Completed elementary	0.072	0.134	0.041	0.138	-0.150
Primary high and above	-0.058	0.186	-0.131	0.205	-0.282
Siblings born alive (1-3)					
0	-0.470	0.272	-0.043	0.316	1.027
4-6	0.065	0.114	0.145	0.113	0.511
7-9	0.125	0.119	0.165	0.118	0.246
10+	-0.075	0.126	0.290	0.131	2.046*
Before age 10, had serious health problem	0.142	0.124	0.122	0.122	-0.086
Education of respondent *(None)*					
Some primary	0.177	0.110	0.061	0.113	-0.708
Complete primary	0.162	0.133	0.131	0.134	-0.150
Junior high	-0.073	0.184	0.311	0.179	1.491
High school and above	-0.103	0.173	-0.130	0.177	-0.135
Respondent's occupation *(Agriculture/forestry)*					
Professional or administrative personnel	-0.575	0.234	-0.037	0.157	1.942
Industrial worker	-0.500	0.207	-0.144	0.112	1.536
Office staff	-0.333	0.205	0.141	0.146	1.929
Service worker	-0.113	0.195	-0.061	0.186	0.228
Other[2]	-0.254	0.189	0.068	0.139	1.409
Individual income (*Below 25%Q*)					
Have no or negative income	-0.089	0.121	-0.089	0.149	-0.168
Above 25%Q, below median	-0.072	0.126	-0.070	0.117	-0.463
Above median, below 75%Q	-0.108	0.126	-0.110	0.118	0.137
Above 75%Q	-0.076	0.131	-0.163	0.127	-0.679
Household assets (*Below 25%Q*)					
Have no or negative assets	-0.047	0.174	0.260	0.203	1.047
Above 25%Q, below median	0.098	0.114	0.174	0.110	-0.092
Above median, below 75%Q	-0.081	0.112	0.110	0.112	0.999
Above 75%Q	-0.046	0.118	-0.159	0.117	-0.813
Married or in consensual union	0.109	0.087	0.064	0.107	-0.326
Smoking behaviors *(never)*					
Started smoking before age 16	0.487	0.186	0.401	0.099	-0.350
Started smoking at age 16 or older	0.239	0.101	0.166	0.087	-0.550
Had diabetes	0.617	0.110	0.464	0.108	-0.980
Had arthritis	0.426	0.106	0.788	0.136	2.112*
Often suffer from pain	1.108	0.085	0.085	0.089	-1.574

Note: [a] This statistics has approximately a standard normal distribution, and * suggests a difference between two coefficients at a significance of 0.05 level.

Data source: Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave.

Table A3 Test for the Equality of Coefficients of Predictors of Severity of Lower Body Functional Limitations Between Male and Female Mexicans Aged 50+ in 2003

	Females		Males		Test statistics [a]
Explanatory Variables	b_1	$s.e.(b_1)$	b_2	$s.e.(b_2)$	$\frac{b_1-b_2}{\sqrt{[s.e.(b_1)]^2+[s.e.(b_2)]^2}}$
Age	0.044	0.004	0.049	0.005	-0.995
Born in high migration state	0.054	0.067	0.028	0.092	0.195
Before age 10, had toilet inside house	0.000	0.085	-0.086	0.122	0.556
Before age 10, often went to bed hungry	0.241	0.071	0.319	0.092	-0.682
Before age 10, family received financial help	0.186	0.108	0.055	0.140	0.863
Lived in urban area with parents	0.047	0.080	-0.131	0.114	1.278
Father's occupation *(Agriculture)*					
Construction	0.147	0.102	0.077	0.145	0.320
Gardening/maintenance/service/store/hotel	0.257	0.098	-0.024	0.141	1.664
In an office/Professional	0.065	0.206	-0.128	0.287	0.488
Other[1] or have no father/ guardian	0.189	0.112	0.127	0.163	0.380
Mother's education *(None)*					
Some elementary	-0.075	0.076	0.017	0.102	-0.764
Completed elementary	0.048	0.118	0.057	0.163	-0.075
Primary high and above	0.076	0.178	-0.046	0.271	0.429
Siblings born alive (1-3)					
0	-0.169	0.253	0.395	0.329	-1.345
4-6	-0.040	0.095	0.104	0.128	-0.868
7-9	0.110	0.099	0.181	0.134	-0.396
10+	0.076	0.106	0.160	0.148	-0.457
Before age 10, had serious health problem	0.171	0.095	0.227	0.127	-0.399
Education of respondent *(None)*					
Some primary	-0.025	0.082	-0.055	0.114	0.201
Complete primary	-0.311	0.107	0.074	0.144	-2.135*
Junior high	-0.337	0.168	0.144	0.201	-1.795*
High school and above	-0.540	0.153	0.145	0.202	-2.609*
Respondent's occupation *(Agriculture/forestry)*					
Professional or administrative personnel	0.345	0.192	-0.299	0.177	2.364*
Industrial worker	-0.082	0.153	-0.005	0.120	-0.369
Office staff	0.036	0.151	-0.027	0.155	0.297
Service worker	-0.036	0.138	-0.215	0.213	0.728
Other[2]	0.055	0.135	-0.048	0.151	0.569
Individual income (*Below 25%Q*)					
Have no or negative income	0.191	0.097	0.200	0.156	0.500
Above 25%Q, below median	-0.058	0.098	-0.079	0.121	1.211
Above median, below 75%Q	0.113	0.101	-0.417	0.129	2.247*
Above 75%Q	-0.049	0.108	-0.270	0.142	2.119*
Household assets (*Below 25%Q*)					
Have no or negative assets	-0.040	0.130	0.004	0.197	-0.173
Above 25%Q, below median	-0.103	0.090	-0.100	0.122	0.173
Above median, below 75%Q	0.054	0.092	0.209	0.124	-1.142
Above 75%Q	-0.092	0.098	0.112	0.134	-1.189
Married or in consensual union	0.012	0.072	0.212	0.115	-1.384
Smoking behaviors *(never)*					
Started smoking before age 16	0.125	0.136	0.124	0.109	0.057
Started smoking at age 16 or older	0.030	0.081	0.226	0.101	-1.445
Had diabetes	0.441	0.077	0.409	0.109	0.272
Had arthritis	0.720	0.072	0.841	0.107	-0.930
Often suffer from pain	1.128	0.065	1.130	0.881	-0.016

Note: [a] This statistics has approximately a standard normal distribution, and * suggests a difference between two coefficients at a significance of 0.05 level.

Data source: Mexican Health and Aging Study (MHAS) 2001 wave and 2003 wave.

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