



## Accounting for Urban versus Rural Discrepancies in Mortality and Functional Health among Older Adults in China

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Acknowledgement: The authors wish to thank Dr. Mark Hayward of the University of Texas at Austin for sharing his SAS macro program. An earlier version of this paper was presented at the annual meeting of the Population Association of America in Philadelphia on April 1, 2005.

August 8, 2006

Working Paper 2006-08-12  
<http://ipia.utah.edu/workingpapers.html>

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## **Accounting for Urban versus Rural Discrepancies in Mortality and Functional Health among Older Adults in China**

### **Abstract**

Broad differences exist in social and economic life between residents living in urban versus rural areas of China. To study the health implications of these differences, the current study employs data from a longitudinal study of older adults in the Beijing municipality, a region of China that has witnessed very rapid socio-economic growth coupled with widening rural/urban gaps in development and health service provision. Life expectancy and active life expectancy, the latter referring to expected years in a functionally healthy state, is estimated for rural and urban samples in a two-step process that involves first, the estimation of hazard rates considering transitions in functional health and mortality and next, the conversion of these rates into transition probabilities for the construction of multi-state life-tables. Estimates reveal a distinct urban advantage in both mortality and functional health. At age 55, urban elders live about 4½ years longer and 5½ more functionally active years than do their rural counterparts, and an advantage is maintained with increasing age. Covariates representing five domains are considered to determine factors that underlie the urban advantage. Socio-economic status and access to health service indicators account for a good deal of the association, social support and health behaviors account for very little, while chronic disease acts as a suppressor. The results have obvious policy implications regarding the need for increasing education, better work opportunities, wider insurance coverage and easier access to health facilities for rural residents of China.

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## INTRODUCTION

Social and economic characteristics of individuals that differ according to place of residence can in turn be consequential for health outcomes, making place of residence itself a health determinant. Location-specific characteristics that influence health include those related to socioeconomic status, behaviors, social cohesion, and access to health service. A primary residential delineation distinguishing social and economic characteristics is rural versus urban residence. Despite this connection surprising little is known about health differences across rural and urban areas, particularly in the developing world (Langmore 2001; Harpham et al. 2003). Furthermore, even in studies that include a rural/urban covariate predicting health, there is typically little consideration of the underlying factors that generate discrepancies.

In the current study we examine first, the extent to which rural/urban differences in health exist with reference to mortality and physical functioning, and second, which of a series of social and economic characteristics play a part in accounting for any residential differences in mortality and function. The setting of the study is the Beijing municipality of China, and the study sample comprises adults aged 55 and older. The Beijing municipality is a particularly attractive location for such a study. The region represents a typical example of the rapid development occurring within China and the concomitant widening social and economic gaps between rural and urban areas. The city of Beijing is developing rapidly, modern buildings and roads are being quickly completed, contemporary and rapid transportation is being expanded, there has been an increase in private sector activities, and access to advanced medicine, quality health practitioners, and otherwise high technology health service is becoming more commonplace and available. In contrast, areas surrounding Beijing remain agricultural, incomes remain low, and improvements to sanitation, clean water, and affordable and quality health services are proceeding at a much slower pace. The stark differentiation in quality of life has prompted Chinese government officials to announce a new focus on strategies aimed at reducing rural versus urban disparities in economic and social development (Kahn 2004).

Moreover, older adults represent a particularly important sub-population to study within this region. China, which has by far the world's largest older population, is aging at an exceedingly rapid rate. The proportion 60 and older was 7% in 1960, 10% in 2000, and will reach 28% by 2040 (United Nations 2003).

Thus, an increasingly larger proportion of functional health problems and mortality will be concentrated amongst the older population, which will in turn have tremendous implications for health services and related costs (Du and Guo 2000; Poston and Duan 2000; Yi and George 2001; Yuan et al 1992). In addition, older adults are overrepresented in rural areas, and, as in many other developing countries, are accounting for an increasingly greater proportion of rural residents due to a process of urbanization among younger adults who move to cities for increasing labour opportunities (Riley 2004). Hence, understanding the mechanisms underlying urban/rural health discrepancies can be important for informing policies that can influence the health of the ever-increasing proportion and possibly increasingly isolated population of rural elders.

Mortality as a health outcome is important to examine for obvious reasons. But, functional health may be an equally critical outcome for older adults since it provides an indication of the degree to which they can conduct usual daily activities and, consequently, the degree to which they require regular assistance. To facilitate examination of health differences across both mortality and functional health, the current study will consider life and active life expectancies. Active life expectancy measures have become widely used for assessing health across population groups in international research (Mathers 2002; Saito, Crimmins and Hayward 1999; Saito, Qiao and Jitapunkul 2003). Active life expectancy estimates partition years of life into states of physical functioning ability, for instance, with and without a functional disability. Using a multi-state life-table approach, the current analysis will first examine estimates of life and functionally healthy life for older Chinese in rural versus urban areas of the Beijing municipality. Next, it will adjust these estimates for a series of characteristics related to four domains that are thought to differ across rural and urban areas - social support, socioeconomic status, health behaviors, health service access - and one health domain that considers differences in illness patterns across rural and urban areas - chronic disease. These adjustments will allow us to assess the extent to which these domains explain and mediate the residential impact of functional health and mortality.

*Rural/urban health*

Differences in health by rural versus urban residence have been in place at least since the industrial revolution, when urban living brought hazards owing to communicable diseases that were transferred more easily across populations living in close proximity (Harpham et al. 2003; Kearns 1988). An epidemiological transition, away from communicable and toward degenerative causes of disease appears to have at first benefited urbanites more so than those in rural areas, mostly due to public health, political factors and social dynamics (Preston and Haines 1991; Preston and van de Walle 1978; Szreter 1997). Then in the 1970s, Kitagawa and Hauser (1973) reported mortality rates in metropolitan areas of the United States to be 5% above those in non-metropolitan counties. A more recent study by House et al. (2000) confirms an urban disadvantage in mortality in the United States even after adjusting for individual-level sociodemographic, economic, and behavioral characteristics.

When it comes to older adults, studies report a rural advantage in mortality and other health outcomes including physical functioning (Clifford and Brannon 1985; Clifford, Miller and Stokes 1986; Hayward, Pienta and McLaughlin 1997; Lassey and Lassey 1985; Miller, Voth and Danforth 1982; Palmore 1983; Patrick et al. 1988; Smith et al. 1995). Hayward et al., (1997) and Smith et al. (1995) both provided evidence that the mortality advantage of rural elders is sustained, and may even increase, after adjusting for socioeconomic and demographic characteristics that relate to health. Since urbanites are consistently shown to have better access to health service, these results, coupled with the more general findings presented by Kitagawa and Hauser (1973) and House et al. (2000), present somewhat of a paradox. The paradox is often accounted for with reference to levels of social support. Specifically, rural areas are characterized by greater social cohesion, more frequent exchange and contact between generations, and generally more affective family relationships (Amato 1993; Beggs, Haines and Hurlbert 1996; Donnenwerth, Guy and Norvell 1978; Gillanders, Buss and Hofstetter, 1996; Lee and Cassidy 1985; Lee and Whitbeck 1987). In turn, social support characteristics have long been implicated as determinants of health and mortality (Berkman and Syme 1979; Chappell 1992; House, Landis and Umberson 1988). Those with greater levels of social support, in this case those in rural areas, are less likely to be vulnerable to disease and more likely to recover from illness.

In the developing world, rural/urban health differences have received surprisingly little attention. What is known suggests that urban areas are better equipped with health services, disease profiles favor urbanites, and consequently urbanites live longer and are functionally healthier (Andrews 2001; Kinsella 2001; Langmore 2001; Harpham et al. 2003). Yet, the issue of who has the advantage is far from settled. On the one hand, it is clear that widespread poverty, poor housing, and a lack of public facilities like water, sanitation and health care, characterize many rural regions of the developing world, and these characteristics are closely linked to health outcomes. On the other hand, some research suggests that changes in diet and other lifestyle behaviors is causing increasing risks of related chronic diseases, such as diabetes, cardiovascular disease and cancer (Popkin 1999; Zhai and McGarvey 1992).

The above suggests that a mortality and functional health advantage among either older urbanites or rural residents in developing countries would be at least partly a function of a set of characteristics that themselves are important health determinants. These include socioeconomic status, access to medical service, healthier behaviors, systems of social support, and generally different chronic health profiles. In the current study, we will consider these as five domains of health determinants.

#### *The Chinese context*

While the definition of rural and urban may be described on a continuum in many parts of the world, particularly in developed countries where urban centers have encroached on rural settings, in China it is much more distinct. This is in large part due to legal designations implemented after the establishment of the People's Republic of China (PRC) in 1949, most notably, a household registration system that divided the entire population into agricultural or nonagricultural populations (Kirkby 1985). The rural/urban distinction was maintained through policies that regulated movement of people, particularly those entering urban areas. Discrete economic, population, social, and health policies have treated these sectors differently, and various advantages, including medical coverage and subsidized food and housing, accrued to those living in nonagricultural areas. These policies resulted in widely different environments and vastly differing characteristics of the people in these areas.

China's rapid transition to a market economy in the 1980s has widened the socioeconomic divide between urban and rural areas due partly to differential investment (England 2005). The gap in the availability and quality of health services has also widened. Historically, China witnessed improvements in health after the establishment of the PRC in 1949 and later during the 1970s (Cook and Dummer 2003; Sidel 1993). China's life expectancy doubled over the last 50 years and is now on par with many developed countries (United Nations 2003). Much of this progress has been attributed to subsidized health service in urban areas and a system of cooperative medical care and free basic and preventive treatment in rural areas (Liu and Wang 1991; Shi 1993). However, the reform era ushered in a decline in cooperative medicine and an increase in privatized fee-for-service in rural China, and the deleterious effects that these changes have had on the availability of and access to health services for rural residents have been well-documented (Bloom, Tang and Gu 1995; Chen, Hu and Lin 1993; Cook and Dummer 2003; Gong and Wilkes 1997; Gu and Bloom 1997; Hsiao 1984; Liu et al. 2002; Meng, Liu and Shi 2000; Sidel 1993; Shi 1993; Wang et al. 1987). While access to health service progresses slowly or stagnates in rural China, most urban residents maintain subsidized care through insurance programs financed from the national budget, have access to qualified medical personnel, and are able to draw upon an array of health resources (Beach 2001; Gong and Wilkes 1997; Shi 1993). According to Beach (2001), 60% of public-health costs now go to 15% of the population living primarily in urban areas. Shi (1996) reports annual out-of-pocket health spending to be about forty times greater for those in rural areas than urbanites.

Differences in health service suggest the hypothesis that older adults in urban areas have a health advantage. However, besides the doubts about a necessary link between the availability of health services and health outcomes that arise from research in the developed world, past research in China is inconclusive. For instance, a higher prevalence of certain chronic health disorders, like hypertension and coronary heart disease, among urban residents have been reported (Zhai and McGarvey 1992; Zimmer and Kwong 2004). This disadvantage may be a function of several factors: changes in lifestyles promoting stresses and unhealthy behaviors; diagnostic difficulties in rural areas that lead to underestimates of reports of asymptomatic diseases; longer survival in urban areas among those living with chronic diseases (Cook and Dummer 2003;

Zhai and McGarvey 1992; Yao, Wu and Wu 1993; Zimmer and Kwong 2004). The latter explanation would suggest that prevalence rates are higher in urban areas, while incidence rates may be higher in rural areas. As for physical functioning differences, in a study of elders aged 80 and older, Yi et al. (2002) found the prevalence of functional disability to be higher among urbanites. The authors suggest that an urban disadvantage in function may be due to a more robust population surviving to old age in rural areas.

Although only a small number of studies have examined active life expectancies in China, these, for the most part, do not examine estimates by place of residence. The one study that did examine it showed a slight rural advantage (Wang M., cited in Saito, Qiao and Jitapunkul 1993). This was, however, based on cross-sectional prevalence rate estimates using the Sullivan method, a technique that tends to have a number of drawbacks (Laditka and Hayward 2003; Sullivan 1971).

## METHODS

### *Data*

Data come from 1992 and 1997 waves of the Beijing Multidimensional Longitudinal Study of Aging conducted at the Capital University of Medical Sciences in Beijing, China. The baseline survey involved a representative sample of older adults aged 55 and over living in three districts in the Beijing municipality. The districts were selected based on their abilities to represent the total municipal area with respect to socioeconomic, demographic and geographical characteristics. Xuan Wu is an urban district located in metropolitan Beijing. The other two are rural districts located outside of the metropolitan area. Da Xing is an agricultural rural plains county south of the city and Huai Ruo is also an agricultural county located further from metropolitan Beijing in a mountainous area to the northeast. Within the three selected regions 3,257 randomly selected individuals completed an interview. The response rate was 90%. There was an over-sampling of oldest-old and urban residents, so a weighting scheme is used to assure that the population within the sample is representative of the three districts in 1992. The 1997 follow-up involved returning to original households. Survival status was determined through interviews with those still living in the household and with others living nearby. Non-respondents included those who moved out of the area within which they



were originally interviewed, or those who otherwise could not be found. Since non-response is higher in Xuan Wu than in the other two districts, an additional weight was constructed to account for differential non-mortality attrition. Nonetheless, response rate for the 1997 wave was also about 90%. More details on the study and the sample can be found in a number of previous publications (Department of Social Medicine 1995; Jiang, Tang and Futatsuka 2002; Jiang et al. 2004; Jiang et al. 2002; Kaneda, Zimmer and Tang 2005; Tang, Jiang and Futatsuka 2002; Tang et al. 1999).

*Estimating life and active life expectancy across rural and urban areas*

Active life expectancy calculations require the division of samples into states of functional health. In both 1992 and 1997, respondents were asked whether they could perform a series of physical functioning tasks without any help from others. Several of these are Activities of Daily Living, or tasks necessary for self-maintenance, and others indicate an ability to conduct basic body movements, often referred to as Nagi items (Katz et al. 1963; Nagi 1965). In total, we use the ability to conduct six tasks to determine whether an individual has a functioning disorder: eating, dressing, getting on and off a bed, bathing, walking 300 meters, and walking up and down a flight of stairs. We define the ‘active’ state as the ability to perform all six independently and the ‘inactive’ state as requiring help in performing at least one.<sup>1</sup> At baseline, individuals are coded as being active or inactive, and at follow-up they are coded as being active, inactive, or having died at some point between baseline and follow-up.

Our estimate of years of life expected in the two functional states of health is derived from a two-step procedure. In the first step, we employ the LIEREG option in SAS to estimate multivariate hazard transition models, which provide estimates for entering and leaving functional states of health. The base transition rate model adjusts rural/urban differences in transitions by only age and sex as described as follows:

$$\ln h_{ij}(x) = \beta_{ij0} + \beta_{ij1} x + \beta_{ij2} \text{Sex} + \beta_{ij3} \text{Urban},$$

where  $h_{ij}$  denotes the transition rate from state  $i$  to state  $j$  in the age interval  $x$  to  $x + 2$ .<sup>2</sup> There are four possible transitions that are estimated: from being functionally active to inactive, functionally active to

deceased, functionally inactive to active, and functionally inactive to deceased, with the omitted transitions being remaining in the active or inactive state. Each estimation procedure then involves a set of four models.

Because the information on functional health is based on observations from two discrete points in time, two assumptions need to be made. First, that only one transition occurs within the interval, resulting in many unobserved transitions. Second, that all events, including censoring, occur in middle of the five-year interval between 1992 and 1997. This allows us to determine conditional hazard rates assuming a discrete-time hazard modeling approach, with results of the transition rates being similar to a standard life-table (Crimmins, Hayward, and Saito 1996).

In the second step, life-table summary measures are determined from the estimated hazard parameters. This is done by converting the matrix of transition rates derived from the hazard parameters into a matrix of transition probabilities, which are then used to calculate a standard set of multi-state life-table functions with the radix population initially distributed according to observed prevalence rates for the two functional states at baseline.<sup>3</sup> Specifics of the calculation can be found in Crimmins, Hayward, and Saito (1994) and Hayward and Grady (1990).<sup>4</sup> The result is an estimate of persons-years lived, at exact age  $x$  for a person of a given sex and residence, in two states of functional health, active and inactive. Of course, the sum of the two estimates will equal total life expectancy. The resulting multi-state life-tables provide the number of expected years of life and the number of expected years of active life for an individual of a given sex and age living in a rural or urban area. The percent of life expected in an active state is easily determined. In the results section of the paper, we at times show that actual life and active life expectancies, and at times we subtract rural from urban years of expected life or active life to show the net advantage of living in a particular area in terms of years.

#### *Accounting for the life and active life expectancy advantage*

The base model that estimates years of life and active life by rural/urban residence adjusting for age and sex will show a distinct urban advantage. Follow-up models will adjust for individual-level social, economic and health characteristics that are likely to differentiate rural and urban residents. Based on the earlier discussion, these characteristics represent five domains: social support, socioeconomic status, health

behaviors, access to health service, and chronic health disease. The latter is included because different disease patterns across rural and urban areas that can have an influence on physical functioning and mortality but are not accounted for in the calculation of active life expectancy. If the rural/urban gap in life and active life expectancy narrows when adjusting for any of these domains, we can conclude that it accounts for some of the advantage and therefore mediates the association between residency and mortality and functional health.

Based on the available data, we are able to employ a series of indicators for each domain, as described below:

*1. Social support.* There are three indicators. Marital status is coded as being currently married or not married. The next two measures are somewhat more qualitative. An item on how often individuals are consulted when making family decisions is employed to indicate feelings of involvement in the family. Those consulted “most of the time” are considered to feel involved. Whether an individual has a confidant on whom they can rely in times of need is determined with a survey question that asks, “do you have anyone that you feel very close and intimate with?” Being married, being consulted regularly, and having a confidant, are considered to indicate higher levels of social support.

*2. Socioeconomic status.* There are three indicators. Education is measured as having any versus having no formal education. Given the items available in the questionnaire, specific occupation codes are difficult to determine, however we employ one questionnaire item that classified the occupation that individuals have had for most of their lives in broad categories (for example, professional, administrator, peasant), and a second that asked whether the work the individual has done most of their lives involved heavy labor. Occupation is coded as white collar and non-heavy labor versus non-white collar and/or heavy labor. Respondents were allowed to say that their occupation was housework. This includes about 14% of respondents. They are coded according to their response to the second item. The third indicator, having financial difficulty, can be considered as a proxy for income, which is difficult to measure among an older population in China. Respondents were asked whether their income meets the needs of their daily living expenses. We code those who report they have enough money as having no financial difficulty. Having

education, a white collar/non-heavy labor occupation, and having no financial difficulty are considered to indicate higher levels of socioeconomic status.

3. *Behaviors.* There are three indicators. First, respondents are coded into ever smokers or non-smokers. Second, they are coded into drinkers of at least one or two drinks a day versus those who drink less or none at all. Third, questions on diet asked about eating fruits and vegetables daily. We code those who answered "yes" as having a healthy diet. Not smoking, not drinking, and eating a healthy diet are considered to be indicators of healthy behaviors.

4. *Acces.* There are four indicators. First, a questionnaire item asked who pays for medical expenses. Individuals could respond that they pay 100% of costs, a medical care program pays for 100% of costs, or they pay for a specific portion and a program pays for a specific portion, the two adding to 100%. Individuals reporting that they personally pay for less than 100% of the costs are likely to be covered by some type of insurance, and having insurance is the first indicator. Second, individuals were asked whether they received a medical check-up over the past year, which is an indication of obtaining regular health service. This indicator clearly may also relate to the behaviors domain. Third, they were asked whether they consider the cost of medical expenses to be a burden. Although this item is correlated with the first ( $r=.361, p < .01$ ), the correlation is not as strong as might be expected, indicating that financial burden is a separate issue from having insurance. Fourth, two items are combined to indicate physical access to health service. Individuals were asked whether they have a problem either with the time it takes to get to the nearest medical facility or the time it takes waiting to be seen by a doctor at their medical facility. Those that respond in the affirmative for either are considered to have problems with physical access. Having insurance, having had a physical check-up, reporting no burden paying for medical expenses and reporting no physical access problems are considered to be indicators of favorable access.

5. *Chronic diseases.* There are two indicators. First, if respondents report ever having coronary heart disease, lung disorders including chronic bronchitis, emphysema or tuberculosis, stroke, diabetes, or cancer, they are coded as having a life-threatening chronic condition. If they report ever having hypertension, asthma, ulcers, migraine headaches, arthritis, glaucoma, or cataracts, they are considered to have a debilitating

condition. While we assume life-threatening conditions would impact on life expectancy, we also assume that debilitating conditions might have greater impact on functional health disorders.

This stage of the analysis begins by adding to the base model variables representing each domain separately, then estimating full models that include all covariates simultaneously. In order to show the urban advantage that is accounted for by covariates in terms of net years, we calculated a series of multi-state life-tables for urban and rural areas. First, one life-table for rural and one for urban residents was determined by adjusting for age, sex, plus significant covariates within each domain separately. Then, life-tables were estimated for rural and urban residents when adjusting for age, sex, plus significant covariates from the full models. For this step we did not calculate separate estimates for men and women, so results can be considered to be an approximate average across sexes. Subtracting expected years of life and active life for rural residents from urban residents provides the net urban advantage. The difference between the urban advantage determined from a life-table that adjusts for covariates from a particular domain and one that adjusts only for age and sex can be interpreted as the life and active life expectancy advantage that is accounted for by that domain.

## RESULTS

### *Differences between individuals in rural and urban areas*

We begin descriptively, showing unadjusted residential differences in mortality, functional health transitions and covariates. Table 1 presents mortality and functional health outcomes by functional status at baseline. It is clear that the outcome is highly dependent upon the baseline status. For instance, 70% of rural residents who were classified as active at baseline were also active at follow-up, while only 16% were inactive. There is the possibility of improvement in functional status among those that were inactive at baseline since 16% of rural and 14% of urban residents and that were inactive at baseline were active at follow-up. Dying prior to follow-up is also very much a function of baseline status. In both rural and urban areas, the percent dying was several times higher among the inactive group.

Initial indication suggests urbanites in the active state at baseline have an advantage over their rural counterparts. A higher percent of those in urban areas that were active at baseline were also active at follow-up, while a lower percent were inactive or died. Among those inactive at baseline, the association is not as transparent and is not statistically significant. Rural residents are more likely to improve to the active state, although the difference is only slight, and they are less likely to die. However, rural residents are also more likely to remain inactive.

Table 2 presents rural versus urban distributions for covariates, including age, sex, and the indicators that fall under the five domains. These figures illustrate that people living in rural versus urban areas have drastically different characteristics. With the exception of sex, all differences are statistically significant. Differences in some socioeconomic status and access indicators are particularly dramatic. Seventy-three percent of the urban sample has some formal education compared to 27% for rural. Forty percent of the urban sample reported their main occupation in life to have been a white collar/non-heavy labor occupation, while the same is true for 4% of rural. Urban elders were almost twice as likely as those in rural areas to report no financial difficulties. Variation in access indicators verifies vast differences in service. Urban elders were many times more likely than their rural counterparts to report having insurance and having had a physical check-up in the past year. They were also much more likely to report medical expenses are not a burden and somewhat more likely to report no physical access problems.

Differences in social support and behaviors are also significant. Interestingly, urban elders appear to be advantaged with respect to social support, which is contrary to urban elders across the U.S. (Beggs et al. 1996; Hayward et al. 1997; Lee and Whitbeck 1987). Urbanites were somewhat more likely than their rural counterparts to be married, report that they were consulted regularly about family decisions, and report that they had a confidant. Urbanites were also more likely to be non-smokers and non-drinkers, and several times more likely to eat fruits and vegetables on a daily basis.

Despite the apparent advantage of urban elders across the social and economic domains, rural elders are less likely to report a life threatening or debilitating chronic disease. There are several possible reasons for this, including higher incidence rates and longer survival in urban areas and a difference in the tendency to

self-report diseases, which itself may be a function of access. In any case, this pattern is consistent with those observed in other studies conducted in China (Zhai and McGarvey 1992; Zimmer and Kwong 1994).

#### *Life and active life expectancies*

Results of base hazard rate models, indicating the effects of residence adjusting for age and sex, are presented in Table 3. The residence estimate can be interpreted as the effect that urban living has on the time that it takes to make a particular transition. For instance, living in an urban area significantly increases the hazard of remaining active relative to becoming inactive, and it also increases the hazard of remaining active relative to dying. This means that urban residents who are classified as active at baseline remain active for a longer period of time than do rural residents before becoming either inactive or dying. In contrast, residence has little impact on transitions from the inactive state. Hence, for those that already have a functional problem, other factors besides residence account for the time they remain inactive relative to improving functional status or dying. In addition, age and sex have generally expected effects. Increasing age decreases time active relative to inactive and dying, and women live longer than do men, regardless of the status at baseline.

Figure 1 shows the resultant life and active life expectancies derived from these hazards by residence, age and sex. The urban life expectancy advantage presented in the left-hand chart is robust. The order from highest to lowest life expectancy is: urban females, urban males, rural females, rural males. The urban/rural net difference is therefore greater than is the male/female difference. As an example, at age 55 an urban woman can expect to live about 23 more years, until the age of 78. Her rural counterpart can expect only about 19 more years, meaning that the urban woman has a four-year advantage. A man at the same age living in an urban area can expect 21 more years of life compared to 17 years for their rural counterparts, again suggesting a four year advantage.<sup>5</sup> The net difference between urban and rural residents declines with age, but the urban advantage remains evident.

Urbanites also have an advantage with respect to functional health. The right-hand chart, which indicates expected years of active life, is unambiguous. At age 55 a man or woman living in a rural area of can

expect about six more active years than can their rural counterparts. The gap remains quite apparent with advancing age, and even at age 85 the urban man or woman can expect about two more active years than their rural counterpart. It is notable that years of active life do not differ much between men and women. Since women live longer than men, as is shown in the left-hand figure, it implies that women spend a greater proportion of remaining years inactive.

Subtracting years of expected active life from years of expected life results in years of inactive life expected. Although it is not shown, those in urban areas can expect fewer inactive years, despite living longer. As a consequence, urbanites also live a greater proportion of remaining life in an active state. Further calculations reveal, for example, that at age 55 an urban woman can expect 92% of her remaining life to be in the active state compared to 84% for her rural counterpart. If both women live to age 85, the difference increases to 72% for the urban woman versus 45% for the rural woman. A man at age 55 can expect 95% of remaining life to be active if he lives in an urban area, compared to 91% for his rural counterpart. By age 85, the gap increases to 86% for the urban man and 60% for the rural man.

#### *Accounting for the urban advantage*

It is clear from the results of the base model that there is a considerable urban advantage with respect to both mortality and function among elders in the Beijing municipality of China. The following section examines whether the various additional covariates account for any of this advantage. We estimated five sets of hazard models that included residence, age, sex, and indicators from each domain separately, then a set of full models that included all covariates simultaneously. The effects for each covariate in the full set of models is similar to effects when adjusting for domains individually in terms of coefficient magnitudes and in terms of significance. Therefore, for presentation purposes, we show only the results of the set of full hazard models in Table 4, which ably represent all the results.

The effects of residence are generally not as strong as was seen in base models. Living in an urban area increases time active relative to inactive, but other urban estimates are insignificant. The magnitude of the significant coefficient is much lower than in the base model. It appears then that some of the urban



advantage is explained by the covariates. How this translates precisely into differences in years of life and active life will be shown shortly.

As for other effects, age and sex are significant and in expected directions. Overall, greater support increases the time that an individual will spend in an active state. Being married and being consulted in family decisions increases time active relative to dying, while there is quite a strong effect of being consulted on remaining inactive relative to dying. The latter suggests that among those with functional disorder, a higher level of support results in longer survival. There are substantial socioeconomic effects among those that are active, with education, occupation and financial status increasing the time active relative to inactive or dying. Socioeconomic effects among those originating in the inactive state are insignificant. This result supports earlier research across a number of countries that has shown the impact of socioeconomic status on functional health transitions to be important only among individuals that begin a period in a functionally healthy state (Grundy and Glaser 2000; Liang, Liu and Gu 2001; Zimmer and House 2003). Behaviors have limited influence with the exception that not smoking delays death among those that are active. There are some quite substantial effects of access. Having insurance and no physical access problems significantly increases time active relative to dying. Physical access decreases time inactive relative to active, that is, it hastens recovery from a functional disorder, and increases time inactive relative to dying, that is, allows those with disorders to survive longer.

Figure 2 shows results obtained from the resultant multi-state life-table calculations. By subtracting estimated years in rural from urban areas across ages, the left-hand chart shows the remaining life expectancy advantage of urbanites when adjusting for various domains and for all domains simultaneously. At age 55 the urban advantage determined by base models, that is, models that only adjust for age and sex, is 4.6 years. (To be specific, the multi-state life-table estimated life expectancy for a 55 year old in the urban area to be 22.0 years, compared to 17.4 years for their rural counterpart.) With increasing age, the net urban advantage decreases, but a distinction remains. At 85, for instance, the urban advantage is 1.3 years. (Life expectancy estimates were 4.8 for urban dwellers and 3.5 for those in rural areas.)

Although the multi-state life-tables that result from adjusting for covariates do not completely eliminate this advantage, some domains clearly have a substantial influence. At age 55, the urban advantage when adjusting for access to health services drops to 2.7 years. In other words, if a 55 year old urban and rural resident had access to the same level of health services, as determined using measures of access available to us, the urban resident could expect to live only 2.7 years longer than their rural counterpart, implying that the other 1.9 years, or 41% of the original difference, is accounted for by access. When adjusting for socioeconomic covariates, the life expectancy advantage of urban residents declines to 3.3 years, meaning that 1.2 years of the original advantage is accounted for by socioeconomic status.

Adjustments for social support and behavior covariates do almost nothing to the urban advantage. For instance, an urbanite at age 55 still has a 4.5 year life expectancy advantage over their rural counterpart even when account is taken of differences in behaviors and social support characteristics. Adjustments for chronic disease, in contrast, increase the life expectancy advantage of urbanites, suggesting that chronic disease differences are benefiting rural residents and suppressing a potentially larger urban advantage. This is due to the higher prevalence of chronic disease in urban areas. For instance, having a lower prevalence of chronic diseases provides a 55 year-old rural resident with 1.5 additional years of life in comparison to their urban counterpart. Also shown in the figure is the difference in life expectancy when adjusting for all covariates simultaneously. These results indicate that a 55 year-old urbanite can expect to live 2.5 more years than their rural counterpart and the advantage is reduced to one year by age 85.

The right-hand side of the figure shows results for active life expectancy. The findings here are similar to those for life expectancy. The advantage at age 55 when adjusting only for age and sex is 5.5 years. By age 85 it drops to 2.2 years. Adjustments for covariates from all domains simultaneously reduce the advantage to 3.3 years for those aged 55 and 1.6 years for those aged 85. Access and socioeconomic status each account for about 1.8 years of the advantage at age 55, and about 0.4 years at age 85. Social support and behavior differences between rural and urban residents explain very little, and chronic diseases have a suppressing effect, increasing the urban advantage when controlled for.

In order to summarize the results, we calculated the percent change in life and active life expectancy estimates when controlling for various covariates. These calculations showed that controlling for all covariates simultaneously accounts for an average of 38% of the urban advantage in life expectancy for those aged 55 to 85 and 34% of the advantage in active life expectancy. However, this total includes the impact of chronic disease, which is to suppress the urban advantage. Therefore, ignoring chronic disease would increase the proportion explained substantially. Of the individual domains, access has the largest impact, accounting for an average of 40% of the urban advantage in life expectancy between ages 55 and 85 and 28% of the advantage in active life expectancy. Socioeconomic status accounts for an average of 24% the advantage in life expectancy and 30% of active life expectancy.

## DISCUSSION

Rural and urban differences in mortality and other health outcomes have been documented in some parts of the world, but there is still limited understanding of how and why location matters, especially in developing countries and among older adults, and how residential discrepancies can be reduced. The issue is however of particular importance since rural/urban is a basic demographic distinction and place of residence is an important health determinant. In China, decades of legal distinctions and more recent reform era changes have resulted in particularly wide rural/urban variations in environments and in the social and economic characteristics that describe individuals. In turn, these variations are likely to have critical implications for the health of older adults. In this paper, we used longitudinal data and an active life expectancy approach to examine the rural/urban gap in two health outcomes, mortality and functional health, among older adults living in the Beijing municipality of China.

Results indicated that in many ways, the characteristics of rural and urban elders differ enormously. Urban elders are far more likely to be educated and have health insurance, to give only a couple of key examples. Crucially for the current study, mortality and functional health experiences diverge greatly, with urbanites maintaining a robust advantage in both net and relative terms on both accounts. Urban men and women at age 55, for instance, can expect more than four additional years of life and more than five

additional years of active or functionally healthy life than can men and women of the same age living in rural areas. The advantage remains evident with increasing age. As a consequence, urbanites experience a proportionally longer period of life in a functionally healthy state.

These findings are consistent with what one would expect if it were assumed that the availability of health services drives health outcomes. Not only is there an imbalance of resources favoring urbanites, but as many have commented, the weakening of cooperative medicine and subsequent introduction of a fee-for-service system has greatly slowed advances in service availability in rural areas (Beach 2001; Chen et al. 1993; Cook and Dummer 2003; Gong and Wilkes 1997; Sidel 1993; Shi 1993). However, differences in the health service environment, troubling as they may be for Chinese policy makers, cannot completely explain health disparities. As has been shown with some certainty in the United States, availability across rural and urban communities does not translate neatly into health advantages. A range of individual-level characteristics may influence how those in different regions negotiate their health environment. For instance, health service may be more readily available in urban areas, but those with low income may be unable to afford treatment, while social support has specifically been implicated as a protecting factor for those living in rural areas (Hayward et al. 1997).

In the current study, we attempted to account for the urban advantage by adjusting life and active life expectancy differences by a series of covariates that reflect the different composition of rural and urban residents. Covariates themselves were shown to have some interesting influences on health outcomes. To provide just a few examples, socioeconomic status, measured as education, occupation and financial status, was shown to be particularly important in maintaining functional health and for survival among functionally healthy individuals, although it had little impact on those that already have a functional disorder. Access, in particular having insurance and having no physical access problems, proved to be important in lengthening both life and active life and in promoting recovery. Health behaviors had surprisingly little influence on health outcomes with the exception that smoking hastened death among some.

More importantly for current purposes, covariates that we classified under domains of access and socioeconomic status reduced considerably the influence of residence on both mortality and functional

health. Controlling for access alone, the urban advantage in life expectancy was reduced by 40%. Controlling for socioeconomic status alone, the urban advantage in active life expectancy was reduced by 30%. There are obvious policy implications to these results. They suggest the need for improvements in education and job opportunities for rural residents and the benefits of a publicly funded health service program that would include broader health insurance and better access to health facilities and practitioners.

In contrast, covariates classified under domains of social support and health behavior explain very little of the discrepancy. These results differ somewhat from those found in the United States. One possible reason for a lack of effect in the Chinese context is, in comparison to socioeconomic status and access, the relative similarity found in social support and behaviors across regions. For instance, normative ideals of filial piety translate into generally high levels of support for older adults in China regardless of place of residence (Bian, Logan and Bian 1998; Leung 1997; Whyte 2003). An indication of this is that a majority of older adults in China live with at least one adult child. Smoking is very common in both rural and urban China, and in fact there is some evidence that urbanites are increasingly engaging in harmful behaviors, such as eating a fatty diet (Du et al. 2004). We also need to consider the possibility that a limited number of adequate support variables were available to us. Actual indicators of the amount and type assistance provided to older adults may have been helpful in this regard.

About 2/3 of the health difference cannot be explained by the covariates included in the current study. This implies a residual effect that may be due to unmeasured individual-level variation or community-level characteristics. Our current data do not allow us to examine the latter, but research elsewhere suggests that variation in environmental conditions that are typical across rural and urban areas may further explain the health differences, while they may also explain variation in health across communities within rural and urban areas (Gillanders et al. 1996; Robert and Li 2001). We suggest that a next step in the research process be the examination of models that incorporate multi-level characteristics and do so on a more extensive geographical basis. Such broad investigations would be beneficial for a number of purposes, for instance, for model building and verification, for assessing the nature of rural versus urban differences on a national level, and for

health policy. Research along these lines would no doubt be critical for determining the level and regions within which policy interventions may be most efficacious.

Our findings bring up several peripheral issues that deserve further discussion. First, we found that controlling for chronic disease has the effect of augmenting the urban advantage. The reason for this is clearly higher prevalence of chronic disease in urban areas coupled with a strong association between chronic disease and other health outcomes.<sup>6</sup> The reasons for higher urban prevalence in this data are unknown, but a legitimate guess is that it is at least partly a result of longer survival with disease. Although it is beyond the scope of the current analysis, future research may benefit from interacting chronic disease and residence when examining mortality outcomes.

Second, the urban advantage in mortality and functional health is primarily a function of advantages in transition rates among those originating in an active state, while urban residence has very little impact on transitions originating from an inactive state. This suggests the possibility of different processes for onset versus progression of functional disorder. This idea is not new and has been discussed in other studies with respect to varying socioeconomic effects on functional health transitions (Grundy and Glaser 2000; Zimmer and House 2003). Borrowing from that discussion, a possible explanation could be that urban residence results in a delay of the onset of functional health problems, but when urbanites do become functionally unhealthy, the severity of their disorder is greater and recovery and survival less probable. Future research would therefore benefit from examining multi-state status-based life-tables that allow for determination of expectancies conditional on initial functional state.

Third, our results are in contrast to an earlier study by Yi et al. (2002), who showed rural residents across twenty-two states of China to be in better physical condition than their urban counterparts. The differences may be a function of several factors, but we believe that the most probable is that our results are limited to the Beijing municipality. Rural areas around Beijing are poor, but are not remote. In more remote areas, there may be on the one hand robustness among those living in rural areas, and on the other some selection occurring where the less healthy die at earlier ages, leaving a healthier population surviving to old age. Yi et al. (2002) consider only the oldest-old, that is, those 80 and older, which may also be a factor. But,

additional analyses we conducted in order to compare our results indicate that even among oldest-old in our sample the urbanites possess better functioning.

One limitation of a study of residence on health outcomes may be the inability to determine causal direction between residence and other covariates. For instance, it is often uncertain whether lower socioeconomic status is caused by living in rural areas or, alternatively, if lower socioeconomic status individuals are somehow drawn to living in rural areas. However, in the Chinese case this limitation is constricted by relatively little migration among older adults between rural and urban areas. Of greater concern for the current study is the potential overlap that exists between indicators in different domains. For instance, it is quite possible that socioeconomic status explains some of the effect of access on health. It is again beyond the scope of the current study, but future analyses could test for the overlap through the use of hierarchical hazard models.

In conclusion, this study finds a strong mortality and functional health benefit accrued to those in urban areas of the Beijing municipality of China. Some, but not all, of the benefit can be explained by better access to service for individuals living in urban areas and higher socioeconomic status among urbanites, both factors which themselves are important determinants of health. Older persons comprise a disproportionate share of the population in rural China and the prospect of poorer health and survival in comparison to urbanites is of great concern. This is especially so given a rural disadvantage in social and economic development and the migration of younger aged adults from rural to urban areas that has the potential of further increasing the imbalance in the proportion of older adults living in rural China. Those in rural China have levels of income well below their urban counterparts, while at the same time they tend to pay for medical costs out-of-pocket, unlike urbanites. This increases the financial burden of disease. Equalizing service opportunities within communities could narrow the gap in quality of life, but our study indicates that individual-level characteristics like higher education, income and access to health insurance are also critical for improving survival chances and functional health transitions.

## ENDNOTES

1 The terms active and inactive are used as convention, although other terms could be functionally healthy versus functionally limited or functionally independent versus functionally dependent.

2 We tested for a variety of functional forms of age dependence for all the transitions in the model. In no instance did a more complex functional form improve the model's fit, compared to a model where the age effect was specified as linear.

3 Previous work has shown that radix differences have negligible effects on life-table functions after only a few years of age (Crimmins, Hayward, and Saito 1994; Rogers 1992).

4 Calculations are aided by a SAS macro written by Mark Hayward and his colleagues when he was at the Pennsylvania State University.

4 Interactions between gender and residence were tested but were insignificant.

5 Further analysis conducted verified a strong association between chronic conditions and mortality and functional outcomes both in rural and urban areas.



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Table 1: Functional and mortality status at follow-up by functional status at baseline and rural/urban residence<sup>1,2,3</sup>

Follow-up status	Status at baseline	
	Active	Inactive
RURAL	(N=811)	(N=244)
- Active	70.4%	15.8%
- Inactive	13.1	30.2
- Died prior to follow-up	16.5	54.0
- Total	100.0	100.0
URBAN	(N=1,529)	(N=255)
- Active	83.0%	14.1%
- Inactive	5.9	24.2
- Died prior to follow-up	11.1	61.6
- Total	100.0	100.0

1 Active status defined as being able to perform six physical functioning tasks without needing assistance. Inactive status defined as needing assistance with at least one task.

2 N's are unweighted.

3 Rural/urban distributions for the active state are significantly different at  $p < .01$ . Rural/urban distributions for the inactive state are not significantly different.

Table 2: Distribution of covariates by rural/urban residence<sup>1,2</sup>

	Rural (N=1,055)	Urban (N=1,784)
Mean Age	65.4	64.6
% female	49.0	50.5
<i>Social support</i>		
% married	72.6	81.0
% consulted regularly	45.9	53.4
% having a confidant	67.2	82.0
<i>Socioeconomic status</i>		
% having education	27.2	73.4
% white collar/non-heavy labor occupation	3.8	40.2
% having no financial difficulties	38.4	65.3
<i>Behaviors</i>		
% never smoked	50.5	55.5
% does not drink	60.1	75.8
% eats fruits and vegetables daily	28.3	67.2
<i>Access</i>		
% having insurance	10.0	91.5
% had a check-up in last year	1.4	21.6
% medical expenses not a burden	42.9	74.7
% having no physical access problems	13.4	17.0
<i>Chronic diseases</i>		
% having life-threatening disease	24.6	42.2
% having debilitating disease	22.9	45.8

1 N's are unweighted

2 Rural/urban distributions are significantly different at  $p < .01$  in all cases, with the exception of is female, which is not significant.



Table 3: Parameter estimates for base hazard rate models

	Transitions			
	active to inactive	active to deceased	inactive to active	inactive to deceased
Residence (1=urban)	+ .943**	+ .517**	+ .097	+ .013
Age	-.064**	-.097**	+ .036*	-.038**
Sex (1=Female)	-.594**	+ .370**	-.588^	+ .304*
Intercept	8.039	9.577	0.803	4.333

\*\* p<.01, \* p<.05, ^ p<.10

Figure 1: Life and active life expectancy by rural/urban residence, sex and age

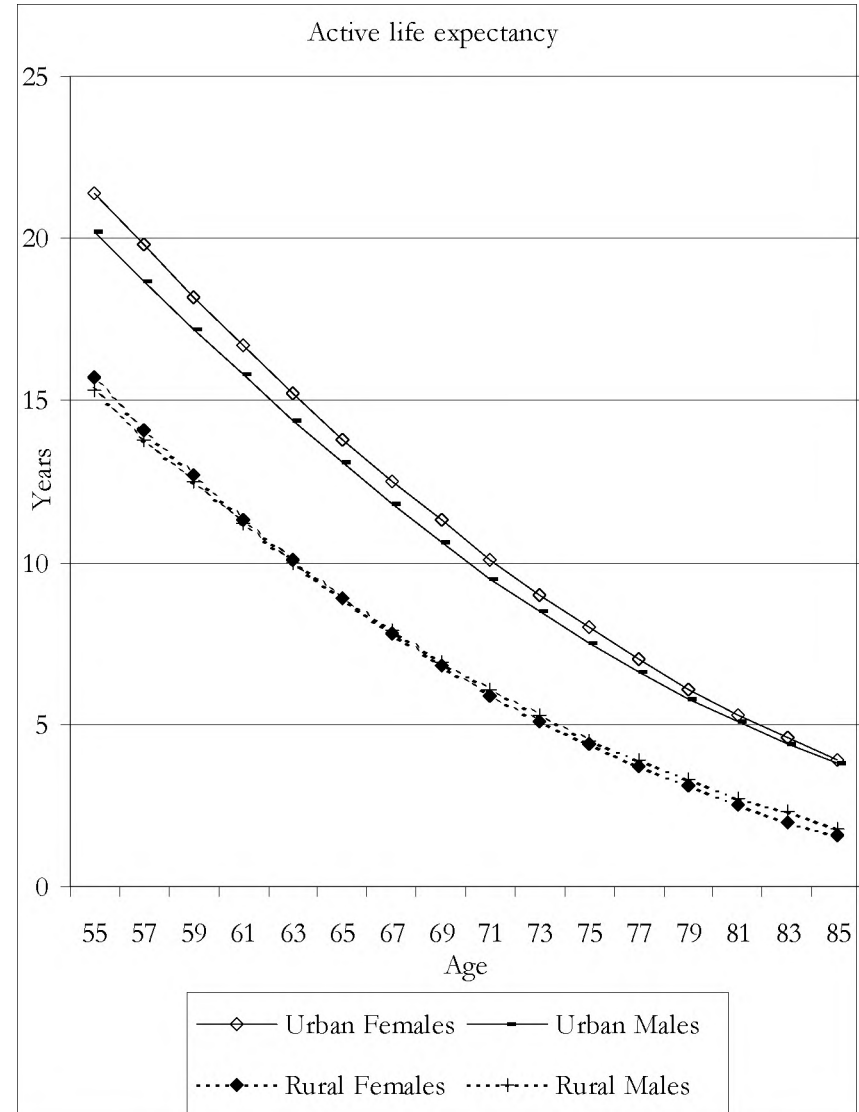
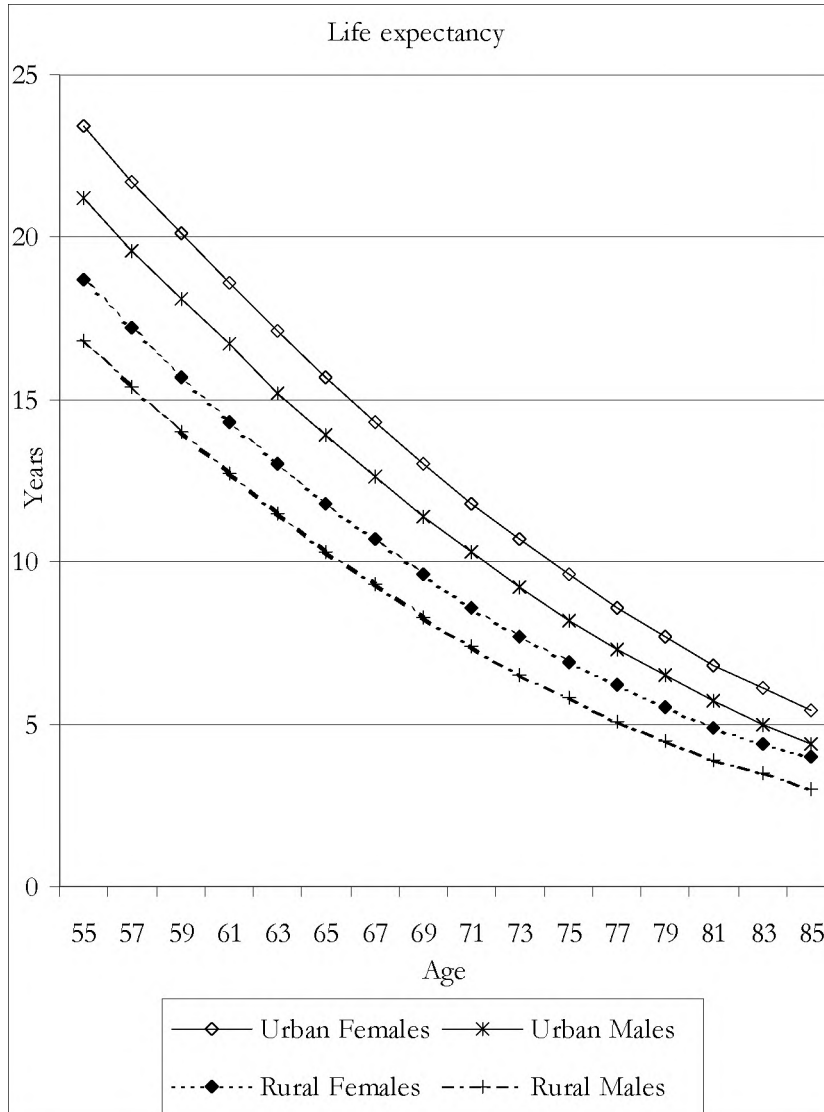


Table 4: Parameter estimates for hazard rate models adjusting for covariates representing five domains

	Transitions			
	active to inactive	active to deceased	inactive to active	inactive to deceased
Residence (1=urban)	+ .578**	+ .124	+ .375	- .035
Age	- .060**	- .082**	+ .036^	- .037**
Sex (1=Female)	- .526**	+ .554**	- .768	+ .206
<i>Social support</i>				
Married	- .151	+ .273*	- .042	- .026
Consulted	+ .108	+ .203^	- .318	+ .473*
Has confidant	- .029	+ .025	+ .204	+ .159
<u>Socioeconomic status</u>				
Education	+ .310^	+ .148	- .494	+ .003
White collar/non-heavy labor occupation	+ .310	+ .411*	- .078	+ .102
No financial difficulties	+ .231^	+ .046	- .247	+ .019
<i>Behaviors</i>				
Never smoked	+ .146	+ .299*	- .035	+ .068
Does not drink	+ .144	+ .134	- .131	+ .159
Eats fruits and vegetables	+ .010	+ .160	+ .117	+ .133
<i>Access</i>				
Insurance	+ .170	+ .350*	- .527	+ .070
Check-up	+ .020	+ .041	- .004	+ .092
Medical expenses not a burden	+ .045	+ .070	+ .116	- .002
No physical access problems	- .041	+ .371**	+ .899*	+ .279^
<u>Chronic diseases</u>				
Life-threatening	+ .123	- .417**	+ .335	- .324^
Debilitating	- .466**	- .272*	+ .113	+ .112
Intercept	8.098	8.027	1.343	4.127

\*\* p<.01, \* p<.05, ^ p<.10

Figure 2: Urban advantage in net years of life and active life expectancy adjusting for various covariates

