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# Influences of Environmental Factors on the Physical Functioning of Older Adults in Urban China

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*This study examined the influence of municipal-level environmental factors (i.e., economy, pollution, health care) on the physical functioning of the elder population in urban China using a two-level hierarchical linear model (HLM) method. Data came from the 2005 wave of the Chinese Longitudinal Healthy Longevity Survey, including 3,830 older adults ( $M_{age} = 86.4$ ) randomly selected from 152 cities across China. Municipal-level data retrieved from the Chinese Statistical Yearbook 2005 include indicators of economic development, pollution, and health service availability. Higher gross domestic product (GDP) per capita and more doctors were associated with fewer functioning limitations. The effect of self-rated health on functioning limitations was moderated by indicators of health service availability. Policies need to eliminate disparities in economic development and health care access across regions.*

**Key words:** ADL limitations, environment, physical functioning, Chinese elders

Physical functioning, defined as individuals' ability to perform basic daily tasks, such as eating, dressing, and bathing, is critical to the well-being of older adults. Complete or partial loss of these capacities is often associated with comorbid medical conditions and predicts such psychosocial problems as social isolation and depression (Stuck et al., 1999). Older adults' physical functioning also determines the amount of care they need from family caregivers and from formal care systems (Kadushin, 2004). Moreover, prevalence of disability leads to high mortality (Bernard et al., 1997; Manton, 2008). Thus, the physical functioning of older adults is a public concern for individuals, families, communities, and society. While gerontological studies have focused on identifying risk factors for declining physical functioning (Stuck et al., 1999), such efforts have often limited their focus to individual-level predictors (e.g., age, health status). The role of environmental factors (such as economic development, pollution levels, and health service availability) in influencing individuals' physical functioning has been less studied (Balfour & Kaplan, 2002; Zeng, Gu, Purser, Hoenig, & Christakis, 2010). Without an understanding of the environmental influences on individuals' limitations in physical functioning, public policymakers and aging service planners may be missing information necessary for providing preventive, rehabilitative or accommodative services.

The impact of the environment on physical functioning may be particularly critical to older adults living in developing countries (Zeng, Yaupel, Xiao, Zhang, & Liu, 2002; Zimmer, Chayovan, Lin, & Natividad, 2004). First, unlike their Western counterparts, many developing countries face rapid population aging prior to industrialization (Zeng et al., 2010). China, for example, has the largest number of older adults in the world. In 2008, China had about 100.1 million adults aged 65 or older, accounting for 23% of the total older population in the world (National Bureau of Statistics of China, 2009). In contrast, the ranking of gross domestic product (GDP) per capita of China was 99th out of the 181 countries listed by the International Monetary Fund (2010). The Chinese government has to address the needs of its growing older population with a lower level of economic development than in Western societies

(e.g., Zimmer & Kwong, 2004).

Furthermore, the rapid economic development currently experienced in China has brought about mixed health consequences for older adults. In the past three decades, China has witnessed an improvement in the health conditions of older adults through increased personal income and access to health care. For example, the life expectancy at birth in China increased from 68 years in 1981 to 73.5 years in 2009 (National Bureau of Statistics of China, 2009). On the other hand, many urban areas witnessed a deterioration of physical environment, such as air and water pollution (Wang, 2004). The interactive influence of economic development and the physical and health environment on the functional capacity of older adults is not yet clear. For these reasons, we believe it is important to examine the roles of environmental factors in influencing the physical functioning of older Chinese persons.

### Literature Review

Physical functioning is often operationalized as an individual's capacity to perform activities of daily living (ADL), which is an important indicator of independence and personal well-being. The emphasis of environmental influences on individuals' health can be dated back to the Chicago School of Sociology (Park & Burgess, 1925), and has been embraced by public health researchers and social epidemiologists (Berkman, 2009; Guralnik, Fried, & Salive, 1996; Yen & Syme, 1999). It has also triggered a recent interest in environmental gerontology (Wahl & Weisman, 2003) that focuses on the close links between physical, social and cultural environments in the context of aging. We adopted a person-in-environment perspective (Wahl, 2006) to examine the relationship between individuals' physical functioning and the environment within which they live. This perspective suggests that older individuals need to respond or adjust to an "environmental press" in order to adapt. Environmental press may result from demands from: (a) the physical environment; (b) the economic environment; or (c) health care systems which may interact with individual characteristics to influence physical functioning (Balfour & Kaplan, 2002).

*Environmental Factors*

In light of existing literature on health and environment (House, 2002; Kaplan, 2004), we highlight three aspects of environment that are believed to be crucial to the physical functioning of older adults: (a) area economic development; (b) level of pollution in the physical environment; and (c) health service availability.

The first environmental factor is area economic development, which can significantly influence the disability rate (Yen & Syme, 1999). In developing countries, disability stems primarily from malnutrition and contagious diseases, which are more likely to diminish as a result of economic advancement than are chronic illnesses, the major cause of disability among older populations in developed countries (Kinsella & He, 2009). Even within a country, community socioeconomic status affects the physical functioning of older adults (Balfour & Kaplan, 2002). In China, Du and Wu (2006) found a lower rate of ADL difficulties among older adults living in well-developed metropolitan areas, like Beijing and Shanghai, than in less developed areas. Explanations of the association between the disability rate and economic level need to consider other confounding factors; areas with advanced economic development also have a greater concentration of advanced technology, medicine, and access to education. Furthermore, the level of area economic development may influence individuals' socioeconomic status, an important correlate to individual physical health (e.g., Yen & Kaplan, 1998; Zimmer & Kwong, 2004). Schoeni, Freedman and Martin (2008) attributed the consistent declines in disability among American older adults to the reduced poverty rate among this population. Because of the complex relationship between economic development and other environmental and individual factors, it is important to sort out the effects of area economic development on the physical functioning by controlling for other factors.

The second environmental factor of interest is the level of pollution of the physical environment. Exposure to polluted air or water can lead to chronic diseases or limit individuals' scope of mobility which, in turn, increases functioning limitations. Evidence is emerging regarding the negative impact of pollution on the physical functioning of older adults (Sun & Gu, 2008; Wang, 2004). For example, Zeng et al. (2010) used

the concentrations of 3 pollutants—sulfur dioxide, nitrogen dioxide, and inhalable particulates—to assess air pollution, and found that air pollution increased the likelihood of developing physical limitations among Chinese older adults. Furthermore, Sun and Gu (2008), using data of older adults from 172 cities in China, found that the physical functioning of older adults living in developed areas is affected more by air pollution than their counterparts living in less developed areas. This could be explained by the close association between socioeconomic development and environmental degradation (e.g., Sun & Gu, 2008; Wang, 2004). Both studies were limited by their cross-sectional design and did not control for health care availability in their analysis.

The third environmental factor is health service availability. Health care availability reflects the level of local economic development and plays a unique role in shaping health outcomes of residents (Du & Wu, 2006; Spillman, 2004). However, this area has rarely been examined. In the two recent studies (Sun & Gu, 2008; Zeng et al., 2010) that examined environmental factors in relation to physical functioning of Chinese older adults, neither examined the health care environmental factors. Health care institutions shaped by social processes may influence the access to and quality of care provided to the population, and we assume that health care service would reduce the ADL disability rates in the older population. Moreover, it is possible that the relationship between individual characteristics and physical functioning could be moderated by the availability of health services. Given little evidence in this regard, we also explored the possible moderation effect of health service availability.

The interrelated complexity between economic development, health service availability, and pollution makes it essential to examine how each might affect individuals' physical functioning. In line with this inquiry, we examined the effects of each environmental influence, and we controlled for known individual-level factors.

#### *Individual-level Factors*

It is believed important to control for the individual-level predictors of physical functioning that have been highlighted in the literature. Functional ability tends to decline most

steeply when people reach old age (Sun et al., 2002; Tang et al., 2001). Du and Wu (2006) analyzed data from a national survey on the functional ability of Chinese older adults and found that for people aged between 60 and 79, only 8.9% needed ADL help, while for people aged 80 and above, one fourth needed ADL help. In addition to age, several other factors were identified in the Chinese literature: gender (e.g., Zeng, Liu, Xiao, & Zhang, 2004); education and income (e.g., Lin et al., 2002); self-rated health (e.g., Lee, 2000); cognitive status (e.g., Zhang, Lu, & Wen, 2003); and activity and exercise engagement (e.g., Guan, Chen, Zhou, Zhang, & Tang, 2002). Being male, better educated, of higher income, and having fewer physical and mental problems and engaging in more exercise/activities are found to be consistently related to fewer functional limitations. National survey data suggest that there is a rural/urban difference in functional disabilities, with rural older adults having a higher disability rate (10.8%) than their urban counterparts (6.9%) (Du & Wu, 2006). Yet, in the published *Chinese Statistical Yearbook 2005* (National Bureau of Statistics of China, 2005), the environmental indexes were not available for rural counties. Thus, this study limits its analysis to older adults residing in urban areas of China.

### Purpose of Study

A review of the literature led to the conclusion that more empirical evidence is needed regarding the effects of specific environmental factors on the physical functioning of older adults in China. Toward the ultimate goal of improving individuals' physical functioning, we believe that public programs focusing on environmental dimensions can benefit more people more profoundly. Using a person-in-environment perspective, we focused on municipal-level influences on ADL difficulties among China's older adults to address two research questions: (1) Do municipal-level environmental factors, including economic development, pollution and health care availability significantly influence the physical functioning of the older adults, after controlling for individual-level factors? (2) Are there any interaction effects between individual health factors and environmental health service factors on the physical functioning of the older adults?

### *Methods*

This study used secondary data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The CLHLS is a national, longitudinal survey of the “oldest-old” Chinese, which were defined by the survey as aged 80 or above. The first wave of the CLHLS was collected in 1998 in randomly selected counties and cities of the 22 provinces, covering about 85.3% of the total population in China. Standardized interview questionnaires and a basic health examination were delivered at the interviewee’s home by either a nurse or a medical student. Data collection in the following waves adopted the same sampling strategies (see detailed description of the original study in Gu, 2008, and Zeng, 2008). This study used the fourth wave data collected in 2005. This wave data included older adults between the ages of 65 and 79, accounting for about one third of its sample. Our analysis did not include rural counties, due to the absence of municipal-level environmental statistics. Participants in this study were older adults (aged 65 or older) who lived in non-institutional settings in urban China. It was these 3,846 older adults from 152 cities in China that comprised the sample analyzed in this study.

### *Participants*

The average age of participants was 86.3 ( $SD = 12.0$ ). Over half were female (56.4%). Participants had completed an average of 3.7 years of education (see Table 1). In Chinese currency, the average income per capita in the household was RMB14669.3 (about U.S. \$2141.10); the average household size was 2.1 ( $SD = 1.6$ ) people. On average, participants’ self-rated health was somewhere between fair and good ( $M = 3.4$ ,  $SD = .9$ ), and their cognitive status was somewhat impaired ( $M = 22.1$ ,  $SD = 9.8$ ).

### *Measures*

The outcome variable was difficulties in ADL functioning. An adapted version of Katz, Down, Cash, and Grotz’s ADL Index (1970) was used to measure ADL difficulties, and its reliability and validity have been established among the Chinese older population using earlier waves of the CLHLS data (Zeng & Vaupel, 2002). Participants were asked to rate how much assistance they needed to perform six ADL tasks (eating,



dressings, using the toilet, bathing, transferring, and continence) on a three-point scale from 0 to 2, with 0 = *no assistance needed*, 1 = *some assistance needed*, and 2 = *cannot do without assistance*. The range of possible total ADL scores was from 0 to 12; higher scores indicate that the participant needs more assistance with ADL tasks. The Cronbach alpha of this scale on this sample was .89.

*Individual-level factors.* Demographic characteristics included age, gender, educational level, and income. Age was measured in years. Gender was coded 0 for males and 1 for females. Education level was measured using years of schooling completed. Income was measured by yearly Chinese dollars per capita in the family.

Health and mental health variables included self-rated health and the Chinese version of Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975; Zeng & Vaupel, 2002). Self-rated health was measured by a single-item question: "How do you rate your health at present?" Participants responded on a five point Likert scale ranging from 1 = *very bad* to 5 = *very good*. The MMSE was used to assess the cognitive functioning of older adults. The Chinese version of the MMSE was translated and modified by Zeng and Vaupel (2002) to reflect the cultural and socioeconomic conditions among the oldest older persons in China. There were a total of 24 questions tapping individuals' abilities in orientation, immediate memory, calculation, recall and language. An aggregated score was calculated with a range from 0 to 30; higher scores indicated better cognitive status. The Cronbach alpha of the MMSE on this sample was .80.

Activity involvement was measured by questions that asked participants how often they were involved in eight specific activities (housework, personal outdoor activities, gardening, reading newspapers, raising domestic poultry or pets, playing cards or mahjong, watching TV or listening to the radio, and attending social activities) on a three point Likert scale ranging from 0 = *never* to 2 = *almost every day*. Total scores ranged from 0 to 16, with higher scores indicating involvement in more activities. The Cronbach alpha of this scale on this sample was .73.

*Municipal-level data.* Municipal-level data were obtained from the *Chinese Statistical Yearbook 2005* (National Bureau of

Statistics of China, 2005) and consisted of two economic indicators (Gross Domestic Product [GDP] per capita and rate of primary industry production), two pollution indicators (concentration of waste water and sulfur dioxide), and two health service indicators (number of doctors and number of beds in hospitals). GDP per capita was measured in Chinese dollars; the primary industry rate refers to the percentage of agriculture or related industry production in total GDP. Concentration of waste water was measured in ten thousand tons, and production of sulfur dioxide was measured in tons. Number of doctors is the total number of doctors, including physicians, specialists, and psychiatrists in a city; the number of hospital beds refers to the number of beds for patients who receive in-patient care.

### *Analysis Strategy*

The Hierarchical Linear Model (HLM) procedure was used to estimate the influence of individual and municipal factors on older adults' perceived ADL difficulties. HLM has the capacity to isolate the influence of individual-level and municipal-level factors on the outcome variable (Raudenbush & Bryk, 2002). We used HLM software (version 6.02, Raudenbush, Bryk, & Congdon, 2005) in this analysis. Two-level HLMs were run to reveal the influences of the individual and municipal factors on study participants' physical functioning. The level 1 model specifies the influence of individual-level factors, including demographics, self-rated health, mental health, and activity. Level 2 models test the effects of municipal-level factors on physical functioning. The two models are represented by the following equations:

$$\text{Level 1 model: } Y_{ij} = \beta_{0j} + \beta_{1j} (\text{demographics})_{ij} + \beta_{2j} (\text{health})_{ij} + \beta_{3j} (\text{mental health})_{ij} + \beta_{4j} (\text{activity}) + r_{ij} \text{ (I)}$$

$$\text{Level 2 model: } \beta_{0j} = \gamma_{00} + \gamma_{01} (\text{economic indexes}) + \gamma_{02} (\text{pollution indexes}) + \gamma_{03} (\text{health service indexes}) + u_{0j} \text{ (II)}$$

$$B_{2i} = \gamma_{20} + \gamma_{23} (\text{health service indexes}) + u_{2i} \text{ (III)}$$

$$B_{3j} = \gamma_{30} + \gamma_{33} (\text{health service indexes}) + u_{3j} \text{ (IV)}$$

In the level 1 model,  $Y_{ij}$  is the outcome variable indicating the ADL scores of individual  $i$  in city  $j$ . This outcome is represented as a function of individual characteristics that include demographics, health, mental health, and activity, and a model error  $r_{ij}$ . Level 1 factors were grand-mean centered so that  $\beta_{0j}$  indicates an average number of ADL limitations for city  $j$ , adjusting for individual-level covariates.  $\beta_{1j}$ ,  $\beta_{2j}$ ,  $\beta_{3j}$ , and  $\beta_{4j}$  indicate how ADL limitations are distributed in city  $j$  as a function of the measured individual characteristics.

In the level 2 model, the intercept ( $\beta_{0j}$ ) and the regression slopes ( $\beta_{qj}$ ,  $q = 1, \dots, 4$ ) are conceived as outcome variables that depend on a set of municipal-level variables (economic development, pollution, and health care) and random effects  $u_{0j}$ . The regression coefficients  $\gamma_{01}$ ,  $\gamma_{02}$ , and  $\gamma_{03}$  indicate the main effects of municipal-level factors on ADL limitations with other covariates controlled. The regression coefficients  $\gamma_{23}$  and  $\gamma_{33}$  reflect whether there are significant interaction effects between individual health factors (i.e., health and mental health) and the municipal-level factor (health service availability). That is, the effects of individuals' health and mental health on ADL difficulties may vary depending on the health service availability in this area.

## Results

We first ran a model without any municipal-level factors (see model 1 in Table 2 and Table 3). This unconstrained model identified that about 9.3% of the total variance in ADL limitations existed at the municipal-level. Individual-level factors including older age, higher education, poorer health, less engagement in activities, and lower cognitive status are statistically associated with more ADL limitations ( $p < .05$ ). No gender differences were identified.

The second model (see model 2 in Table 2) added the main effects of the municipal-level factors. Controlling for individual-level factors, we found that higher GDP per capita ( $B = -.14$ ,  $p < .05$ ) and more doctors ( $B = -.22$ ,  $p < .05$ ) were related to fewer average ADL difficulties among the older population in a city (see model 2 in Table 2). On the other hand, more hospital beds ( $B = .33$ ,  $p < .05$ ) were associated with more average ADL limitations among the older adults in a city. The

two pollution indices were not significantly related to ADL limitations. The significance of the random effects (see U1, U2, and U3 in model 2 in Table 3) suggests that the slope effects of acidity, MMSE and self-rated health on ADL limitations were significantly different across cities. This finding justified an inclusion of the third model that examined whether health care environmental factors would explain the different slope effects of individual-level health indicators (i.e., MMSE and self-rated health) across different cities.

Table 1. Descriptive Results of Variables in this Study

Variables	<i>M</i> or %	<i>SD</i>
ADL difficulties	1.6	2.9
<i>Individual-level factors</i> <span style="float: right;"><i>n</i> = 3846</span>		
Age	86.4	12.0
Female	56.4%	
Income <sup>1</sup>	14559.3	22292.7
Education	3.7	4.7
Activity	18.2	7.2
Self-rated health	3.4	0.9
Cognitive status	22.1	9.8
<i>Municipal-level factors</i> <span style="float: right;"><i>n</i> = 152</span>		
Primary industry rate <sup>2</sup>	17.3	10.1
GDP per capita <sup>1</sup>	16354.9	12260
Waste water <sup>3</sup>	10400	14240
Sulfur dioxide <sup>3</sup>	33700	29530
# of beds	13905	12810
# of doctors	7943	7357

Note. <sup>1</sup> Measured in Chinese dollars. <sup>2</sup> Primary industry rate is the proportion of primary industry generated GDP in total GDP. <sup>3</sup> Waste water was measured in ten thousand tons, and sulfur dioxide was measured in tons.

The third model (see model 3 in Table 2) included the interaction effects of health care environmental factors and

Table 2. Fixed Effects Estimates for Models of the Predictors of ADL

Parameter Fixed Effects	Model 1 <i>B (SE)</i>	Model 2 <i>B (SE)</i>	Model 3 <i>B (SE)</i>
Intercept	1.33*** (.12)	1.28*** (.12)	1.41*** (.12)
<i>Level 1: Individual factors</i>			
Age	.01*(.01)	.02*(.01)	.02*(.01)
Female	-.05(.06)	.07(.06)	.07(.06)
Education	.07***(.01)	.07***(.01)	.07***(.01)
Income	.001(.001)	.001(.001)	.001(.002)
Activity	-.11***(.01)	-.10***(.01)	-.11***(.01)
Self-rated health	-.57***(.04)	-.50***(.05)	-.54***(.04)
Cognitive status	-.12***(.01)	-.10***(.01)	-.11***(.01)
<i>Level 2: Municipal level factors</i>			
Primary industry rate		-.09(.08)	-.09(.08)
GDP per capita		-.14*(.07)	-.14*(.07)
Waste water		-.10(.06)	-.10(.06)
Sulfur dioxide		.01(.07)	.01(.08)
# of beds		.33*(.14)	.77*(.32)
# of doctors		-.22*(.11)	-.47*(.24)
<i>Interaction effects</i>			
Slope for self-rated health			
# of beds			-.42*(.21)
# of doctors			.41*(.21)
Slope for MMSE			
# of beds			-.04(.04)
# of doctors			-.001(.04)

Note. *B* indicates fixed effect estimates. *SE* = standard error. \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

individual health and cognitive status on the ADL. The interaction effects between health care environmental factors with the slopes of MMSE were not significant. Yet, we found that the effect of self-rated health on physical functioning varied depending on the number of doctors and hospital beds. Because interaction effects are intuitively difficult to explain, we provide two figures that plot these interaction effects. Figure 1 indicates that the effect of self-rated health on physical functioning was greater in areas of fewer doctors than in areas with more doctors. In other words, individuals’ self-rated health

on their physical functioning tends to diminish as the area’s number of doctors increases. Figure 2 indicates that the effect of self-rated health on physical functioning is more salient in areas with more hospital beds than in areas of fewer hospital beds. In other words, individuals’ self-related health tends to become more important to their physical functioning as the area’s number of hospital beds increases.

Table 3. Random Effects for Models of the Predictors of ADL Limitations

Random Effects	Model 1		Model 2		Model 3	
	Variance SD	$\chi^2$ df	Variance SD	$\chi^2$ df	Variance SD	$\chi^2$ df
Level 2						
Intercept, $U_0$	.47 .68	***424.77 129	.56 .75	***468.64 105	.57 .75	***426.08 105
Activity, $U_1$			.004 .06	***182.80 111	.004 .06	***182.82 111
Health, $U_2$			.06 24	**157.68 111	.07 .26	**150.45 109
MMSE, $U_3$			.003 .05	***235.87 111	.002 .05	***176.34 109
Level-1, R	4.58 2.14		4.23 2.06		3.88 1.97	

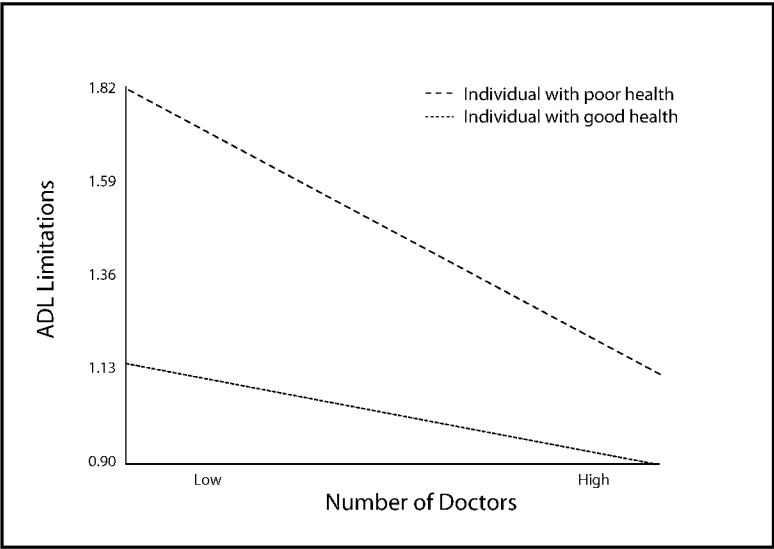
Note. \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

Discussion

As expected, we found individual-level factors—including younger age, engagement in more activities, higher levels of cognitive functioning, and better self-reported physical health status—related to fewer ADL difficulties. Interestingly, we found a positive relationship between years of education and ADL difficulties in the multivariate model. One possible explanation could be that people with higher education might be able to report or recognize their ADL limitations. Another alternative explanation is that, when controlling for the positive side effects of education (i.e., better income, activity involvement, and better cognitive status), the years of schooling might

lead to a lower probability of engaging in labor-intensive work that could help develop resilience against physical functioning deterioration. We recommend future research to disentangle different aspects of education that could indirectly influence physical functioning.

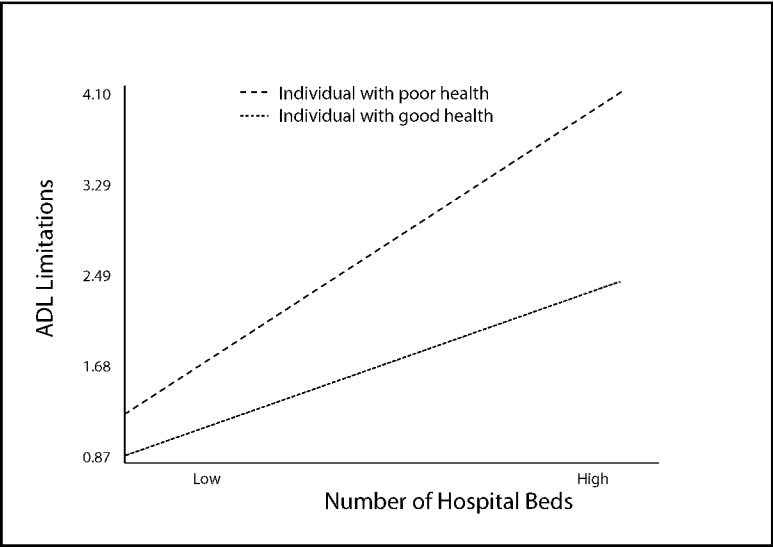
Figure 1. The Effect of Self-rated Health on ADL Depending on the Number of Doctors in the Area



The two-level HLM analyses disentangled the significant environmental effects from the effects of individual characteristics. As expected, there is a small, but statistically significant, variance (9.3%) in physical functioning due to municipal-level factors. Health care environment and economic factors seemed to outweigh the influence of pollution on the physical functioning of older adults. Higher GDP per capita is related to lower prevalence of physical disability, consistent with findings in Western literature (Beard et al., 2008) and in some Chinese literature (e.g., Du & Wu, 2006). In areas with higher economic development, older adults tend to have fewer ADL limitations than in areas with lower economic development. In this study, we can conclude that economic development contributes to the lower rate of functioning disabilities of the older population, independent of health service availability and individual

factors that include education, activity, physical and cognitive health status.

Figure 2. The Effects of Self-rated Health on ADL Limitations Depending on the Number of Hospital Beds in the Area



Our study did not find that the pollution indicators in an area have an impact on older adults’ physical functioning. First, the measures of pollution we chose—the concentration of waste water and sulfur dioxide—might not fully capture pollution. Sun and Gu (2008) used the concentration of nitrogen dioxide and inhalable particulates, which might have a more direct effect on physical functioning. Second, in using same year pollution index statistics, we may not have been able to detect the effects of pollution that are believed to be cumulative (Zeng et al., 2010). Third, it is possible that pollution has been kept under control by local governments so that there are negligible effects on individuals’ health. As China has focused on environmental protection, particularly in well-developed urban areas, different programs may have been in place to contain the exposure of harmful particulates or to reduce the effects of air pollution on residents’ health.

This study found the effects of health service availability on physical functioning dependent on the nature of services. The ADL limitation rate among urban older adults is



positively related to hospital beds, but inversely related to the number of doctors. Such relationships need to be understood in the health care context in Chinese society. Chinese doctors, including physicians, psychiatrists, specialists, and traditional Chinese medicine practitioners, often provide services to patients in preventive and primary care settings. The availability of doctors might be a proxy measure of the availability of timely prevention or treatment of diseases that cause physical limitations among older adults. The interaction effect between number of doctors and older adults' self-rated health further suggests that the availability of health professionals' expertise could counteract the effect of self-evaluated health status on one's own physical functioning.

To explain the positive association between the number of hospital beds and the physical limitations of older adults, we note that many hospitals in China provide long-term nursing care. In spite of the effort of the Chinese government to increase health care efficiency by reducing the length of hospital stay, the current length of hospital stay in China is longer than in Western countries. For example, in 2005, the average length of stay in the hospital was 10.9 days (Ministry of Health of China, 2009), which is about twice as long (4.8 days) as in the U.S. (National Center for Health Statistics of the U.S., 2009). In China, geriatric patients tend to stay much longer in hospitals due to their comorbid medical conditions, the limited number of nursing homes, and dislike of such facilities. Accordingly, we believe that the association between number of hospital beds and physical limitations of ADL patients could be due to the Chinese health care systems in which hospitals still partially serve a long-term function. The interaction effect found between the number of hospital beds and self-rated health suggests that in tertiary or long-term care settings, individuals' self-related health and physical functioning is more closely related.

There are a few limitations to this study. First of all, we were limited to the municipal-level data that are available in a statistical yearbook. We did not include other characteristics of neighborhood environment, such as crime rate and transportation access (Balfour & Kaplan, 2002) or mobility barriers in the physical environment for older adults, such as stairs, uneven sidewalks, and poor public transportation (Keysor, et al., 2010). Second, this study only focused on urban areas,

and future studies need to expand to rural counties. The great variation in rural counties in terms of socioeconomic development might allow researchers to observe more substantial environmental effects on older adults' physical functioning. Third, the cross-sectional design of this study prevented us from establishing a cause-effect relation between environmental factors and individual physical functioning. Future studies should examine the roles of environmental factors on changes in physical functioning using longitudinal research design and the mechanisms through which such environmental factors influence physical functioning.

This study has some implications for practice and policy in China. Preventions or interventions need to involve individuals in activities or programs that are beneficial to cognitive and physical health. Interventions at the macro level should not be limited to building more hospitals beds to accommodate the needs of physically disabled older adults. Developing the local economy and increasing the availability of health professionals (e.g., occupational therapists, physical therapists) for the physically disabled should be a consideration for local policy-makers and service planners.

Findings of this study might enlighten policymakers in other countries dealing with similar consequences of health disparity due to unbalanced economic development and distribution of health care resources. It is unfortunate, but true, that our findings suggest a consistent conclusion that residents in poor areas/countries have lower access to health services than those in better-off areas/countries. Peters et al. (2008), in their study of global health service access, reported that the number of hospital beds per 10,000 people in Southeast Asia is 9 compared to 25 in the Americas, and the gap widens slightly in the ratio of doctors per 10,000 people, which is 5.2 in Southeast Asia versus 19.4 in the Americas. Even within a developed country, residents in less developed areas tend to have less access to health care resources than those in developed areas. For example, the U.S.A. is the only member of Organization for Economic Cooperation and Development (OECD) countries that does not have a universal health policy. Rural older Americans tend to have more physical functioning problems and report poorer self-rated health than their urban counterparts (Rosenthal & Fox, 2000). The number of physicians per capita in rural areas is less than half that of urban

area, and nursing home beds are disproportionately used by rural older Americans, due to a lack of alternative community-based health services (Rosenthal & Fox, 2000). In light of such evidence, policymakers need to take into consideration both economic and health factors in their effort to shorten health disparity.

To conclude, this study represented an initial effort to explore environmental factors on the physical functioning of older urban Chinese. Although individual characteristics are most influential in affecting a Chinese elder's physical functioning, the effect of social environments is not insignificant. Given the paucity of research in this area, we recommend more research be conducted to thoroughly examine the impact of environmental factors mentioned in this study on the physical functioning of older adults.

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