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Competing interests: None declared.

The views expressed in this article are those of the authors and do not necessarily reflect those of HelpAge USA, HelpAge International, Duke University, or the United Nations.

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Associations between human rights environments and healthy longevity: The case of older persons in China

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Abstract

Individual health can deteriorate through neglect or violation of human rights, or can improve through favorable health policies and programs on human rights. Yet quantitative associations between human rights and health are insufficiently studied. Based on a nationwide dataset of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) with more than 18,800 adults aged 65 and older in mainland China interviewed in 2002 and 2005 and their follow-ups three years later, we examine how an individual's longevity and health are associated with some domains of human rights. We use three individual-level variables in early life stages (whether a respondent went to bed hungry, whether they accessed adequate medical services, and how many years of schooling they received), three individual-level variables at present (whether a respondent has adequate housing, whether they have adequate economic resources to support daily subsistence, and whether they receive adequate medical services when needed), and one community-level variable (air quality) as proxies to measure several fundamental domains of human rights in terms of access to adequate food/nutrition, housing/shelter, education, social security, health care, and clean-air environments. An indicator of healthy survival is introduced to measure survivors at sequent follow-ups with a good health condition. Our results demonstrate that better conditions of proxy measures of human rights at different life stages, especially at present, are associated with a higher likelihood of healthy survival after taking various confounding variables into consideration, suggesting the possibility of a significant linkage between good environments in human rights and healthy longevity. These findings may have important implications for promoting better environments in human rights, especially in the context of population aging.

Introduction

Human rights, as defined by the United Nations, are universal rights held to belong to individuals by virtue of their being human, encompassing civil, political, economic, social, and cultural rights and freedoms, based on the premise of personal human dignity and worth.[1] However, views differ as to what rights are encompassed by human rights, and as to their moral and legal normative value.[2] A report issued by the United Nations Office of the High Commissioner for Human Rights (hereafter OHCHR) elaborates some rights, including the right to life; the right to the enjoyment of the highest attainable standard of physical and mental health; the right to adequate food; the right to adequate housing; the right to education; the right to social security; the right to participate in public affairs; the right to be free from torture or cruel, inhuman, or degrading treatment or punishment; the right to freedom of opinion and expression; the right to a fair trial; the right to work; the right to liberty and security of person; the right to non-discrimination and equality; and the right to freedom from violence against women.[3] These are the most recognized and defined rights, and they are all indivisible and interdependent.[4] For example, the right to the enjoyment of the highest

attainable standard of physical and mental health is closely linked to the rights to adequate food, housing, education, social security, and so forth. Yet most of these rights are difficult to measure.[5]

As an individual's health can deteriorate through neglect or violation of human rights, or can improve through favorable health policies and programs adhering to human rights, it is crucial that we examine the effect of human rights environments on the health and survival of older adults. In doing so, we can better understand how, in the context of rapid population aging, an improvement in human rights may reduce health inequality and improve quality of later life.[6] Yet there are very few existing studies that quantitatively analyze the effects of exposure to good or bad human rights environments. This is largely due to limited data and difficulties in quantifying the human rights indicators.

Some researchers have provided an illuminating framework for how socioeconomic status affects health throughout the life course. These aging studies simultaneously consider longitudinal exposure to socioeconomic conditions and the multifaceted social contexts that shape the risks and resources of the individual.[7] This framework has been tested in different populations, and the findings reveal that a higher childhood or contemporary socioeconomic status is closely associated with better health and a lower mortality risk among older adults. Some others investigate how community or neighborhood contextual factors affect individual health and mortality using an ecological framework, and find that a better condition in a neighborhood likely enhances health conditions and reduces mortality risk among its residents.[8] Wen and Gu integrate the life course framework with the ecological framework, and the application of that framework in China supports these findings.[9]

Given the difference between the conditions or environments of human rights and socioeconomic status, it is unclear whether the findings from the socioeconomic status perspective still hold from the human rights perspective. The present study investigates the associations between the human rights environments experienced in different life stages and healthy longevity at older ages among Chinese older people. The study views the associations through the lens of a human rights-based approach after incorporating life course and ecological perspectives. We focus on human rights domains that include rights to adequate food, shelter, education, and social security because of their overlap with socioeconomic status, an indicator whose associations with health and mortality are well-documented in research of aging. Another reason for the focus is that the right to health, nutrition, shelter, and education can be measured as proxies for universal human rights across all countries, although they may have some country-specific contextual constraints.[10] We selected China because it is an ideal sample to examine how human rights environments affect healthy longevity in a developing country with a unique social environment in terms of culture, population structure, and political and socioeconomic system. Furthermore, because older persons are more vulnerable to external environments, and because the global population is aging, studying associations between exposure to good human rights and healthy longevity can inform policies and population aging studies.[11] Given the gender differences and the urban-rural differences in human rights in China, our analyses are stratified by gender as well as urban-rural residence.[12]

We first review the evolution of the concepts and indicators of human rights, as well as the possible mechanism by which the condition of human rights is linked to healthy longevity. We then describe the data sources and methods used to fulfill our research goals. Finally, we present our major findings and interpret the results.

Evolution of human rights measurements and its limitations

Although the attempts to use indicators to assess human rights have been ongoing since the 1950s, conceptual and methodological frameworks for identifying the relevant quantitative indicators of human rights have only recently been sought.[13] Early human rights indicators consisted of qualitative gradient rating systems, which do not provide useful information for ways forward.[14] In response to the difficulties of qualifying and quantifying these rights with such broad ranges, international human rights organizations within the United Nations and in civil society have been endeavoring to establish a conceptual and methodological framework on indicators for human rights assessments contextualized for each country.[15] The OHCHR started work on indicators in 2006, seeking to use statistical information in country reports in assessing the implementation of human rights under a broader framework that includes content (the structural element), process, and outcomes.[16]

In 2008, the OHCHR issued a report on indicators for promoting and monitoring the implementation of human rights" and released a list of illustrative indicators identified on a number of human rights and thematic issues as outlined in the opening paragraph of this paper, which is an outcome of serial consultations and workshops with a panel of experts as well as country-level stakeholders.[17] The human rights indicators identified by the OHCHR have distinct attributes. For example, the OHCHR identified five attributes for the right to health: sexual and reproductive health; child mortality and health care; natural and occupational environments; prevention, treatment and control of diseases; and access to health facilities and essential medicines.[18]

Although the right to clean air is not included in the OHCHR's human rights and there is presently no global treaty recognizing such a right, there are many global declarations and resolutions, dating back to the 1972 Stockholm Declaration, that address and support the recognition of the right to clean air. Furthermore, majority member states of the United Nations do recognize such a right, and four regional treaties have explicitly recognized this right, including human rights agreements in Africa, Latin America, and the Middle East plus the Aarhus Convention, ratified by several European and Asian nations. The UN General Assembly and various UN organs have also repeatedly endorsed the right to clean air, albeit sometimes in ambiguous language.[19]

Development in human rights indicators has facilitated monitoring and assessment of human rights, as well as the implementation process in member states. However, there are some limitations for the current vision of human rights indicators. First, human rights within the United Nations focus mainly on country-level indicators. While this is useful and pragmatic, it may not be representative of all individuals. This would introduce some biases when we analyze the impacts of failure or success in human rights implementations using individual-level datasets that are becoming increasingly available. Second, different indicators are of varying importance in determining one's health and well-being in different life periods for different groups of populations. Third, it is useful to quantitatively measure some fundamental components of human rights within in a single country, even if they cannot be compared globally, emphasizing individual rights-holders.[20]

Pathways linking human rights with health

Aging studies have identified three major groups of factors or determinants of health or mortality at older ages.[21] The first group is material resources that contain factors such as housing and neighborhood quality, the financial means to buy items such as healthy food and warm clothing, and physical work or living environments. This group includes many indicators that are similar to some domains of human rights, which are also the focus of the present study. The second group is psychosocial factors that consist of personal predisposition, social relationships and social support, and coping styles. The third group is the interaction of behavioral and biological factors that include nutrition, physical activity, tobacco consumption, alcohol consumption, and some genes and other genetic components.

Long-term health is the result of direct and indirect sequelae and advantages. Although adult or contemporary conditions remain the most commonly addressed aspects of health and mortality disparities in the study of aging, there is a growing recognition that conditions in early life stages have long-term effects on health and mortality at older ages.[22] The pathways linking childhood conditions to later health and survival may be direct or indirect. Direct mechanisms refer to adverse conditions experienced early in life that have long-term negative effects on health in old age, independent of achieved status in adulthood or at present, whereas indirect mechanisms refer to advantaged early life conditions that could contribute to greater educational attainments and higher achieved social statuses in adulthood, which protect health and reduce risks of disability mortality in later life.[23] This life course perspective emphasizes that individual health outcomes should be viewed in the long term, examining earlier conditions that shape later health.[24]

An abundance of literature has documented the significant direct effects of psychosocial characteristics on health and the significant direct and mediate effects on mortality.[25] Behavioral factors likely produce more impacts on health and mortality than psychosocial factors. In some cases, psychosocial and behavioral factors have a greater power than material factors in explaining mortality differentials in subpopulations.[26]

There also has been marked growth in studies explor-

ing how neighborhood characteristics affect health outcomes of their residents beyond the effects of individual-level characteristics.[27] In general, the beneficial effects of community conditions may occur because of the health-promoting resources of the social, physical, and service environments of local neighborhoods.[28] Socioeconomically advantaged communities often enjoy a desirable physical environment equipped with, for example, greater amounts of green space and better access to neighborhood amenities.[29] These may include recreational options, high-quality food, and health and social services.[30] Higher community socioeconomic conditions are also positively associated with local interpersonal features such as neighborly trust and social cohesion.[31]

In summary, factors relating to individual health are extremely complex. Material and psychosocial factors interact with an individual's health through behavioral and biological factors. These are further impacted by broader socioeconomic factors such as wealth and income, occupation, education, gender, race or ethnicity, and geographical location of residence.[32] In an even broader way, civil and political factors could result in an unequal distribution of power, prestige, and resources to exercise control over many of these other factors.[33]

Data and measurement

Data

This study utilizes data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), a nationwide longitudinal survey of healthy longevity conducted in 22 provinces in mainland China. The CLHLS aimed to interview all centenarians in the randomly sampled half of counties/cities in the 22 provinces. Age of each centenarian was validated from various available sources, including birth certificate, genealogical documents, household booklet, and, when available, children's and siblings' ages.[34] For each centenarian interviewed, the CLHLS randomly chose one nearby octogenarian and one nonagenarian with pre-designated age and gender (based on the centenarians' pre-designated random code) to be interviewed. This sampling strategy ensured that the CLHLS gathered data from comparable numbers of randomly selected male and female octogenarians and nonagenarians at each age from 80 to 99. Starting in 2002, the CLHLS extended its sample to cover old persons (aged 65-79) who were sampled with the same principle as the oldest-old (aged 80 or older). To ensure sufficient

sample size in subsequent waves, the CLHLS recruited a new sample at each subsequent wave to replace those who were lost to follow-up or who died within survey intervals. The age and sex of each newly interviewed respondent at a subsequent wave was the same as the person who was lost to follow-up or died within survey intervals. This replenishing design is a common practice in longitudinal surveys.[35] A detailed description of the survey has been widely reviewed.[36] We restrict our analyses to the respondents who were interviewed in the third (2002) and fourth (2005) waves of the CLHLS and their follow-ups in 2005 and 2008 because the first two waves of the CLHLS (1998 and 2000) did not recruit old persons aged 65 to 79, who are the subjects of our inquiry.

Excluding those lost to follow-ups, 18,833 participants aged 65 or older are included in this study with 25,302 observations, of which 12,364 respondents had two interviews (i.e., one follow-up or one episode) and 6,469 respondents had three interviews (i.e., two follow-ups or two episodes). Systematic assessments show that the overall data quality of the CLHLS is quite high.[37] Such assessments also show that respondents who are female, living in urban areas, physically impaired, and with low levels of social contact are more likely to have higher attrition rates.[38] Nevertheless, the loss to follow-ups is unlikely to introduce significant biases in the analysis because the sample distributions of the followed-up respondents are very close in key variables to those for all sampled respondents, regardless of re-interview status.[39] Empirical study has shown that the effects of sample attrition on models of factors predicting outcomes do not depend on how the loss to follow-up samples differs from all those who are eligible to be re-interviewed, but on how re-interviewed respondents differ from all eligible sampled respondents.[40]

Proxy measures of human rights

Thanks to the CLHLS that has collected a rich set of variables, we found several variables directly reflecting or closely relevant to human rights, including food, housing, education, social security, environment, and health. We selected six dichotomous variables at the individual level and one continuous variable at the community-level as proxies to measure conditions of several broadly applicable components of human rights for each respondent in his or her different life stages. Specifically, the variables consist of three individual-level variables measuring condi-

tions in early life stages: adequate medical service (yes or no), sufficient nutrition (yes or no), and years of schooling (zero years or one year or more). Sufficient nutrition is measured by whether a respondent went to bed hungry. As the majority of older persons in China are illiterate, educational status is dichotomized between those who have never received formal education and those who have received one or more year of schooling, following an earlier study on Chinese older persons.[41]

The other three individual-level variables measure human rights conditions at present (i.e., at the time of the survey): whether a respondent has adequate financial sources to pay daily subsistence (yes or no), whether the respondent could get adequate medical service when in need (yes or no), and whether a respondent (or his/her spouse) has his/her own bedroom (yes or no). The seventh variable is the level of air quality. The level of air quality is the reversal of the widely used air pollution index, which is measured at the community level (i.e., city level), and reported in the Chinese Natural Resources database.[42] Air pollution indexes are widely used in environmental research to measure general air quality.[43] It assesses the concentration of five pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter less than 10 microns in diameter (PM10), carbon monoxide (CO), and ozone (O_3). Air pollution index is then graded into air pollution level (APL) with seven levels from one to seven, with higher scores indicating a better air quality. Due to the lag effect between air pollution and health as noted by some studies, we use the 1995 data. We assume that counties within the same prefecture-level city share the same air quality as the data of APL are only available at the prefecture-level.[44]

From definitions, we are confident that these seven variables adequately reflect some basic domains of human rights reviewed above. Furthermore, because six of these variables to a great extent are also proxies for socioeconomic status that are associated with health and mortality among older adults in epidemiological and health economics literature, we are able to apply some well-established frameworks in these areas to human rights studies.[45] To better present the findings, we generate three indexes to approximately reflect the overall environments of human rights that each respondent might have experienced in their different life stages. The first is an overall proxy index for the lifetime by adding all six individual-level dichotomous variables together. This measure has a

score ranging from zero to six. The second one is an overall proxy index in childhood, calculated by adding three childhood variables with a score ranging from zero to three. The third one is an overall proxy index in adulthood and older adulthood, calculated by adding three dummy variables in adulthood with a score ranging from zero to three. The higher the index score, the better human rights environment one may have experienced.

Outcome variables: Healthy longevity

We combine survival status (died or survived) and overall health condition at follow-up waves to measure healthy longevity with three categories: healthy survival, non-healthy survival, and death. Specifically, if a respondent survives to a subsequent wave and is in good health, they are coded as healthy survival. If a respondent is still alive in a subsequent wave but not in good health, he or she is coded as non-healthy survival. The health condition is measured by a cumulative health-deficit index that has been increasingly used in aging research over the past decade.[46] The cumulative health-deficit index (DI) is an unweighted count of the number of deficits divided by the total number of possible deficits for a given person. We use 39 indicators, including self-reported health, cognitive functioning, disabilities in activities of daily living (ADL) or instrumental activities of daily living (IADL), functional limitations, auditory and visual ability, depression, heart rhythm, and numerous chronic diseases that were collected in the CLHLS to compute the DI. ADL disability refers to difficulties in performing bathing, dressing, toileting, indoor transferring, and eating, whereas IADL disability refers to difficulties in performing cooking, grooming, laundering, walking, taking medicines, or using public transportation. These 39 items are similar to those used to calculate DI in other studies from Canada, the United States, and Hong Kong.[47] We dichotomize individual indicators/items and code them as one when a deficit is present. Consistent with prior research, we assign a score of two if the respondent had a serious illness that caused him or her to be hospitalized or bedridden two or more times during the last three years.[48] Thus, the total number of possible deficits is 40. We then compute the deficit index by summing all deficits and dividing by the total number of possible deficits (range=0~1). The validity of the health deficit index in the CLHLS datasets has been verified.[49] A detailed list of variables used to construct the health deficit index is published

elsewhere.[50] We use the criterion of index less than 0.1 (similar to lowest quartile) to define the healthy sample in comparing with the unhealthy sample.

Control variables

We further control for several other covariates, at both the individual and community levels, that are associated with individual health and mortality risk. The individual-level covariates include age, sex, ethnicity (non-Han versus Han), urbanicity (urban or rural), family and social support measured by current marital status (married or unmarried), health practices measured by smoking at present (yes or no), alcohol use at present (yes or no), and doing regular exercise at present (yes or no), and psychological predisposition in terms of optimism. The optimism is measured by "do you look at the bright side of things" (yes or no). We also control for overall health conditions in terms of DI measured at baseline. The community-level covariates include per capita gross domestic product (GDP) in 2000 that is available for each city district or county.[51] There are 977 city districts or counties in the present dataset.

For the sake of simplicity, all individual-level covariates except for age and number of living children are coded dichotomously. We have tried other categorizations and found only minor differences between the dichotomous and non-dichotomous results. To capture a possible non-linear relationship between GDP per capita and individual health outcomes, we use the categories adopted by the World Bank in 2002, which classify countries and regions into five categories based on annual income per capita: poverty (≤ $365), low income ($366-$745) lower middle income ($746-$2,975), upper middle income ($2,976-$9,205), and high income (> $9,205).52 Because the highest GDP per capita in our sample is approximately $2,367, we classify it into three categories: low, medium, and high, corresponding to the three lowest categories defined by the World Bank.

Methods

We use two-level random-intercept multinomial logit models to address associations between human rights proxy measures and healthy longevity. Level one is individual level and level two is community level (i.e., county/city in the present study). The random-intercept and fixed-slope design is a widely used approach in multilevel analyses, which assumes that the community-level variables are associated only with the intercept at the individual level.[53] All individual variables are centered at their group means according to conventional multilevel analyses.[54]

We assess multicollinearity among covariates and the largest variance inflation factor is lower than three, indicating no multicollinearity biases of concern in the models. The percentage of missing data is less than 2% for all variables. Following recommendations in early research, we use modal and mean values to impute missing data for the categorical and continuous variables, respectively.[55]

In modeling the associations between healthy longevity and the human rights environments exposure in childhood, adulthood, and over lifetimes, we control all covariates simultaneously. Due to the aforementioned differences in human rights environments experienced by men and women, and by urban and rural residents, we present results by age group, sex, and urban-rural residence. We do not use weights in our models because the weight variable available in the CLHLS only reflects sampling by age and sex, and we control for these factors in the model. This is a common and acceptable approach used in multivariable regression modeling.[56] Preliminary analyses confirm that the overall patterns and conclusions are similar between the weighted and unweighted data. All analyses are conducted using HLM 6.0.[57]

Results

Table 1 presents the sample distribution for three overall proxy indexes and six individual proxy measures of human rights, healthy survival, and all covariates by age group, sex, and urban-rural residence. Generally speaking, younger-old persons, aged 65-79, have been exposed to slightly better human rights environments, as compared to the oldest-old, aged 80 or older. Women tend to experience poorer human rights environments than men, whereas urban older persons tend to experience better human rights environments than their rural counterparts. We see substantial differences in demographics, psychosocial, behavioral, and health profiles between younger-old persons and the oldest-old, and between women and men. There are also some differences in behavioral characteristics between urban old persons and rural old persons.

Table 1. Distributions of the sample, CLHLS 2002-2005

Variables	Total	Ages 65-79	Ages 80+	Women	Men	Rural	Urban
Number of individuals	18,833	5,481	13,352	10,882	7,951	10,937	7,896
Health outcomes[a]							
% deaths	42.6	11.0	55.5	45.2	38.9	43.2	41.7
% non-healthy survival	44.6	59.6	38.5	44.6	44.7	44.1	45.3
% healthy survival	12.8	29.3	6.0	10.2	16.4	12.7	13.0
Individual-level characteristics							
Proxy measures of human rights							
Mean score in lifetime (ranging from 0 to 6)	3.65	3.93	3.54	3.37	4.04	3.44	3.95
Mean score in childhood (ranging from 0 to 3)	1.08	1.28	0.99	0.84	1.40	0.91	1.31
Mean score in adulthood (ranging from 0 to 3)	2.58	2.65	2.55	2.53	2.64	2.53	2.64
% went to bed without hunger in childhood	31.9	33.3	31.4	30.2	34.2	26.1	40.0
% got adequate medical service in childhood	39.4	41.5	38.5	37.1	42.4	34.9	45.6
% received one or more years of schooling	36.3	53.2	29.4	16.4	63.6	30.0	45.1
% with sufficient financial security	79.2	80.1	78.8	77.8	81.0	76.5	82.8
% get adequate medical service at present	88.3	92.3	86.7	87.0	90.1	85.6	92.0
% having own bedroom	90.2	92.4	89.3	88.6	92.4	90.7	89.4
Covariates							
Mean age	86.7	71.3	93.1	88.7	84.0	86.7	86.7
% male	42.2	51.1	38.6	0.0	100.0	41.7	42.9
% urban	41.9	41.1	42.3	41.4	42.6	0.0	100.0
% Han ethnicity	93.6	94.1	93.5	93.4	93.9	92.3	95.5
% married	31.3	66.3	16.9	17.5	50.1	30.1	33.0
% current smoker	18.7	28.3	14.7	7.1	34.4	19.9	16.9
% current alcohol drinker	20.7	24.4	19.2	12.0	32.7	22.1	18.8
% currently exercising regularly	29.3	38.8	25.4	22.7	38.3	22.1	39.3
% optimistic	69.0	77.9	65.3	65.0	74.4	66.6	72.2
Mean of DI score at the baseline[b]	0.094	0.047	0.113	0.107	0.075	0.092	0.096

Table 1. Distributions of the sample, CLHLS 2002-2005 (cont'd.)

Variables	Total	Ages 65-79	Ages 80+	Women	Men	Rural	Urban
Community-level factors[c]							
Number of communities	977	518	835	810	738	667	716
% medium per capita GDP in 2000	46.8	47.5	47.3	46.8	46.2	49.0	46.2
% high per capita GDP in 2000	38.3	39.4	38.2	38.6	38.5	34.8	39.7
Mean of good air quality in 1995 (ranging from 1 to 7)	4.16	4.00	3.94	3.93	3.93	4.00	3.93

Table 1 notes:
(1) a: distributions for two 3-year intervals: 2002-2005 and 2005-2008 with loss to follow-up excluded; b: DI: cumulative deficit index, ranging 0~1, which was calculated from 39 variables.
(2) c: means or percentages for the community-level factors are calculated based on countries/cities that are classified by respondents' age, gender, and urban/rural residence.
(3) all variables are unweighted and measured either in 2002 for the respondents who were interviewed that year, or in 2005 for the respondents who were first interviewed then.

Table 2 shows results from multilevel multinomial logit regressions that examine associations between human rights environments in childhood, at present, and lifetime and healthy survival without adjusting for baseline health. The results in the upper panel of Table 2 show that when demographics, psycho-social, and behavioral factors are taken into consideration, the increase of each additional score in the overall proxy index of human rights increases the odds of healthy survival relative to death by 11% over a three-year period (p<0.001) . The odds ratios (OR) of healthy survival relative to death are slightly higher in young older persons aged 65-79 (OR=1.16, p<0.001) than those in the oldest-old aged 80 or older (OR=1.08, p<0.05). Similar odds ratios are found between men (OR=1.10, p<0.001) and women (OR=1.12, p<0.001) and between urban older persons (OR=1.12, p<0.001) and rural older persons (OR=1.10, p<0.001) without stratifying by age.

Patterns for healthy survival versus death by gender and urban-rural residence are slightly changed when the sample is further analyzed for different age groups. For young older persons aged 65-79, the beneficial effects of good human rights environments (odds ratios ranging from 1.13 to 1.23) are greater than those for the oldest-old (ranging from 1.07 to 1.08) for both men and women and both urban and rural older persons. Furthermore, the effect sizes of good environments of human rights on healthy survival are relatively larger for urban men (OR=1.16, p<0.001) than for rural men (OR=1.06, p<0.1) and for rural women (OR=1.15, p<0.001) than for urban

women (1.09, p<0.05).

The upper panel of Table 2 also shows that compared to the environments of human rights experienced in childhood, the current human rights environments are more important to older persons' healthy longevity. With three exceptions (urban women, urban oldest-old, and young older women), in all other 19 models, good contemporary human rights environments yield better odds for healthy survival. In many cases, increases in every additional score in human rights could increase the odds of healthy survival by 30-50%. The environments of human rights experienced in childhood produce much smaller benefits to healthy survival at old ages. In four out of 21 cases, childhood human rights environments could produce significant long-term benefits to healthy longevity. This is mainly found in younger or urban old persons and women.

The lower panel of Table 2 reveals that odds ratios of healthy survival relative to non-healthy survival for human rights environments in a whole lifetime and at present are only slightly changed as compared to odds ratios of healthy survival relative to death. The age, gender, and urban-rural residence differential patterns are similar between odds ratios of healthy survival relative to death and odds ratios of healthy survival relative to non-healthy survival. A notable difference between the lower and upper panels is that the childhood human rights environments have no significant impact on healthy survival (as compared to non-healthy survival) in old age.

Table 2. Odds ratio (OR) of healthy longevity for proxy measures of human rights, CLHLS 2002-2005

	Overall Proxy Measures of Human Rights		
	Lifetime	Childhood	Adulthood
Healthy Survival vs Death			
Total	1.11***	1.03	1.29***
Ages 65-79	1.16***	1.12**	1.27***
Ages 80+	1.08*	1.01	1.24***
Women	1.12***	1.05	1.28***
Men	1.10***	1.02	1.30***
Rural	1.10***	1.00	1.30***
Urban	1.12***	1.07*	1.28***
Ages 65-79, women	1.13*	1.15*	1.12
Ages 65-79, men	1.18**	1.09	1.41***
Ages 80+, women	1.08+	0.98	1.30**
Ages 80+, men	1.07+	1.03	1.19***
Ages 65-79, rural	1.12**	1.05	1.25**
Ages 65-79, urban	1.23***	1.21**	1.34**
Ages 80+, rural	1.08*	0.98	1.29**
Ages 80+, urban	1.07	1.04	1.17
Women, rural	1.15***	1.04	1.37***
Women, urban	1.09*	1.08	1.14
Men, rural	1.06+	0.99	1.22**
Men, urban	1.16***	1.06	1.50**
Healthy Survival vs Non-Healthy Survival			
Total	1.09***	1.03	1.25***
Ages 65-79	1.11***	1.03	1.29***
Ages 80+	1.06*	1.01	1.19**
Women	1.10**	1.03	1.26***
Men	1.08***	1.03	1.24***
Rural	1.10***	1.02	1.27***
Urban	1.09**	1.04	1.22**
Ages 65-79, women	1.14***	1.07	1.29***
Ages 65-79, men	1.08*	1.00	1.29***
Ages 80+, women	1.05	0.96	1.24**
Ages 80+, men	1.08+	1.06	1.15+
Ages 65-79, rural	1.11**	1.02	1.29***
Ages 65-79, urban	1.11**	1.04	1.30**
Ages 80+, rural	1.07+	1.00	1.24**
Ages 80+, urban	1.05	1.03	1.11
Women, rural	1.12**	1.02	1.30***
Women, urban	1.08*	1.06	1.18*
Men, rural	1.09**	1.02	1.25***
Men, urban	1.08*	1.03	1.24*

Table 2 notes:

(1) All OR estimates are based on two-level multivariable multinomial regressions adjusting for all covariates except the cumulative deficit index listed in Table 1 and community-level variables.

(2) a, the lifetime proxy index of human rights is the summation of three individual-level proxy measures of human rights in childhood and three in adulthood, ranging from 0 to 6; b, human right indices for childhood and adulthood range from 0 to 3.

(3) +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

However, when baseline overall health (that is, overall health status three years ago) is further controlled for, the odds ratios of human rights environments are substantially reduced and some of them turn out to be insignificant, indicating that baseline health has a crucial role in determining subsequent health and survival (Table 3). Yet there are still many cases in which better human rights environments at present could improve the odds of healthy survival; patterns for age, gender, urban-rural patterns are similar to those odds ratios without controlling for baseline health. Childhood human rights environments have very weak associations with healthy survival, especially when comparisons are made among survivors at subsequent waves.

To test the possible mediate effects of contemporary human rights environments and other covariates on childhood human rights environments, we conducted additional analyses by including the overall human rights index in children and other covariates in the models while excluding the human rights index at present (Table 4). We find that without considering psychosocial and behavioral factors as well as present human rights environment, better human rights environments in childhood do yield some positive benefits to healthy longevity at old ages (Table 4: Model 1). However, when psychosocial or behavioral factors and present human rights environments are taken into account, many significant associations between childhood environments and healthy survival disappear (Table 4: Models 2 and 3), indicating that psychosocial and behavioral factors and human rights environments at present have some mediated effects on the association between childhood human rights index and healthy survival at old ages.

Table 5 shows that when baseline health is excluded, air quality is significantly associated with healthy longevity after adjusting for all individual-level variables studied. In almost all cases, the increase in each additional level of air quality improves odds of healthy survival by 5-16% relative to death, and by 8-10% relative to non-healthy survival. These significant associations become insignificant when baseline overall health is adjusted for.

Discussion

Based on the data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), we have examined individuals' exposure to some domains of human rights at various life stages, and how this could promote healthy longevity. One important finding of the present study is that for this Chinese sample, proxy measures of human rights environments are significantly associated with healthy survival. This is the case even when adjusting for demographics, psychosocial and behavioral factors, and baseline health, regardless of age, gender, and urban-rural residence. These results suggest that universal exposure to good human rights environments improve one's healthy longevity. These findings also imply that although old men or urban older persons likely have better human rights environments than their female or rural counterparts, the mechanism linking human rights environments and healthy longevity is similar across subpopulations.[58] These findings are also in line with results from demography, epidemiology, and gerontology studies using similar variables.[59]

Our findings have important implications for promoting better environments in human rights, especially in the context of population aging. For example, the realization of the enjoyment of the right to the highest attainable standard of health relies heavily on effective and integrated health systems that encompass both medical care and the underlying determinants of health.[60] China has made substantial progress in establishing a national social security system that includes old-age pensions, medical care, and a minimum standard of living scheme. However, for older Chinese adults today, especially for the rural older persons, coverage of social security and medical insurance is not high. Many have difficulty paying for their daily subsistence and medications.[61] This is due to insufficient funds for health care access, often because of a lack of work-related income, and the lack of a coherent plan for social protection.[62] Additional problems exist with some existing pension funds, where the rates of return are lower than the market rate.[63] China also has a weaker institution-building capacity than many of today's developed countries.[64] Family care resources based on filial piety

Table 3. Odds ratio (OR) of healthy longevity for proxy measures of human rights (baseline health controlled), CLHLS 2002-2005

	Overall Proxy Measures of Human Rights		
	Lifetime	Childhood	Adulthood
Healthy Survival vs Death			
Total	1.06*	1.03	1.12**
Ages 65-79	1.09*	1.10*	1.10
Ages 80+	1.03	1.01	1.09
Women	1.08*	1.07+	1.11+
Men	1.04	1.00	1.13*
Rural	1.02	0.97	1.11*
Urban	1.11*	1.10**	1.13+
Ages 65-79, women	1.07	1.14*	0.97
Ages 65-79, men	1.11*	1.06	1.23*
Ages 80+, women	1.04	1.00	1.14
Ages 80+, men	1.02	1.01	1.05
Ages 65-79, rural	1.02	1.00	1.06
Ages 65-79, urban	1.21**	1.23*	1.19
Ages 80+, rural	1.01	0.96	1.12
Ages 80+, urban	1.06	1.07	1.04
Women, rural	1.07+	1.02	1.18*
Women, urban	1.08+	1.13*	1.00
Men, Rural	0.98	0.94	1.04
Men, Urban	1.14**	1.08	1.36**
Healthy Survival vs Non-Healthy Survival			
Total	1.06**	1.02	1.15**
Ages 65-79	1.07*	1.02	1.17**
Ages 80+	1.04	1.01	1.11+
Women	1.07*	1.04	1.16**
Men	1.05+	1.01	1.14*
Rural	1.05+	0.99	1.16**
Urban	1.08**	1.06	1.14*
Ages 65-79, women	1.10*	1.07	1.17*
Ages 65-79, men	1.04	0.98	1.17*
Ages 80+, women	1.03	0.97	1.16+
Ages 80+, men	1.05	1.05	1.08
Ages 65-79, rural	1.05	0.99	1.15**
Ages 65-79, urban	1.10*	1.06	1.20*
Ages 80+, rural	1.04	0.98	1.16+
Ages 80+, urban	1.04	1.04	1.04
Women, rural	1.06	1.00	1.19**
Women, urban	1.08+	1.07	1.10
Men, rural	1.04	0.99	1.14*
Men, urban	1.07+	1.01	1.17+

Table 3 notes: (1) All OR estimates are based on two-level multivariable multinomial regressions adjusting for all covariates listed in Table 1 and community-level variables.
(2) a, the lifetime proxy index of human rights is the summation of three individual-level proxy measures of human rights in childhood and three in adulthood, ranging from 0 to 6; b, human right indices for childhood and adulthood range from 0 to 3. (3) +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

(a central component of Confucian philosophy and care for older people in contemporary China) are likely to decline with decreasing family size in the future. Community- and home-based services targeted to old persons are largely underdeveloped.[65] Furthermore, mortality and health in a society is largely determined by how evenly wealth is distributed rather than the overall wealth of that society.[66] Support for steps addressing wealth inequality, the development of community-and home-based social service programs, and the establishment a medical care system with full coverage for its residents, especially rural residents, women, rural to urban migrants, and the urban poor, will ensure that high economic growth will bolster older persons' enjoyment of human rights.

The study also finds that good air quality is strongly associated with healthy longevity. This suggests that a compromise in the right to clean air would deteriorate one's health and thus degrade the right to health. This finding is in line with other studies in international epidemiology and health economics.[67] It has a critical implication in developing public health and preventive health programs in the context of population aging and environmental degradation, especially in China. Although China is the world's second largest economy, its high economic growth rate has been accompanied by deteriorating air quality. Seven of the 10 most polluted cities in the world are in China, and this has offset or compromised the economic growth.[68] Regulations for improving air quality have been implemented for more than a decade, yet progress has been slow.[69] More restrictive enforcement of environmental rules could help China benefit more from economic growth and improve the health of Chinese citizens of all ages. In summary, our findings provide empirical evidence to support the argument that neglect or violation of human rights may degrade individuals' health. The findings also highlight the importance of formulating favorable public health policies and programs on human rights.[70]

In contrast to some aforementioned studies in gerontology that find that childhood conditions are associated with health and mortality at old ages, we find that human rights environments in childhood produce very limited effects on healthy longevity in old age. There are several possible explanations for this non-significant effect. First, our proxy measures may not accurately capture the environments in childhood that are important for mortality trajectories at older ages. Second, human rights environments at present, as well as psychosocial and behavioral factors, mediate the impact of childhood human rights environments on health and mortality. Third, an individual's health condition in old age is a cumulative outcome determined by environments experienced over 65+ years. It is likely that compared to 65+ years of initial health measurements, our analytical time period may be too short to detect significant associations between these measures and the subsequent mortality among older persons. Fourth, mortality selection may play certain roles in dropping those people who were exposed to poorer human rights environments in childhood from the study cohorts before they survive to old ages, and especially to oldest-old ages.[71] Our findings clearly warrant an extended interval of the follow-up period to verify our hypotheses. Studies of socioeconomic status and health and mortality at old ages show that socioeconomic conditions in adulthood or late ages have greater impacts than conditions at earlier life stages on predictability of health status at later ages.[72]

It is understandable that baseline health (i.e., health at a previous wave) plays a critical role in determining subsequent health and survival in a short period, and our results support this argument.[73] It follows that contributions of studied variables to subsequent health and survival status would be largely reduced once we account for baseline health. Many social epidemiological studies focusing on associations between socioeconomic status and health/mortality find that health practice variables slightly mediate, and baseline health greatly modifies, the associations between socioeconomic status and health/mortality.[74] Although the studied association in the present study is slightly different, the underlying mechanism of mediation is likely the same. We welcome additional research to further shed light on the role of baseline health in determining healthy survival at late ages.

Table 4. Odds ratio (OR) of healthy longevity for proxy measures of human rights in childhood, CLHLS 2002-2005

	Overall Proxy Measures of Human Rights in Childhood		
	Model I	Model II	Model III
Healthy Survival vs Death			
Total	1.10***	1.08**	1.05+
Ages 65-79	1.20***	1.16***	1.13**
Ages 80+	1.07*	1.05	1.02
Women	1.12**	1.10*	1.06+
Men	1.09*	1.06	1.03
Rural	1.07*	1.04	1.02
Urban	1.14***	1.12**	1.09*
Ages 65-79, women	1.22**	1.20**	1.16*
Ages 65-79, men	1.17**	1.12+	1.12+
Ages 80+, women	1.03	1.01	0.99
Ages 80+, men	1.09+	1.08	1.03
Ages 65-79, rural	1.12*	1.09	1.07
Ages 65-79, urban	1.30***	1.26***	1.23**
Ages 80+, rural	1.05	1.02	0.99
Ages 80+, urban	110+	1.09	1.05
Women, rural	1.10*	1.08	1.05
Women, urban	1.14*	1.12*	1.08
Men, rural	1.05	1.02	1.00
Men, urban	1.15**	1.11*	1.08+
Healthy Survival vs Non-Healthy Survival			
Total	1.06*	1.04	1.04
Ages 65-79	1.06+	1.04	1.04
Ages 80+	1.05	1.03	1.02
Women	1.07+	1.04	1.04
Men	1.05+	1.03	1.04
Rural	1.06	1.03	1.03
Urban	1.07*	1.06	1.05
Ages 65-79, women	1.11*	1.09+	1.08+
Ages 65-79, men	1.03	1.00	1.01
Ages 80+, women	0.99	0.98	0.97
Ages 80+, men	1.10+	1.08+	1.07
Ages 65-79, rural	1.06	1.04	1.04
Ages 65-79, urban	1.07	1.05	1.06
Ages 80+, rural	1.04	1.02	1.01
Ages 80+, urban	1.06	1.05	1.03
Women, rural	1.06	1.04	1.03
Women, urban	1.08	1.07	1.06
Men, rural	1.06	1.03	1.04
Men, urban	1.06	1.04	1.04

Table 4 notes: (1) All OR estimates are based on two-level multivariable multinomial regressions adjusting for all covariates listed in Table 1 and community-level variables.
(2) human right index in childhood ranges from 0 to 3.
(3) Model I controls for demographics; Model II adds human rights index at present to Model I; Model III additionally adjusts for psychosocial and behavioral factors. (3) +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

Table 5. Odds ratio (OR) healthy longevity for air quality, CLHLS 2002-2005

	Without controlling for baseline DI		With controlling for baseline DI	
	Healthy Survival vs Death	Healthy Survival vs Non-Healthy Survival	Healthy Survival vs Death	Healthy Survival vs Non-Healthy Survival
Total	1.12***	1.07*	1.04	1.03
Ages 65-79	1.11***	1.06	1.06	1.03
Ages 80+	1.13***	1.08*	1.04	1.03
Women	1.11**	1.05+	1.04	1.02
Men	1.12**	1.08+	1.05	1.04
Rural	1.11**	1.07+	1.03	1.03
Urban	1.13**	1.07*	1.06	1.04
Ages 65-79, women	1.16*	1.06	1.10+	1.02
Ages 65-79, men	1.07	1.07	1.03	1.04
Ages 80+, women	1.05*	1.06	1.02	1.00
Ages 80+, men	1.15**	1.10*	1.06	0.99
Ages 65-79, rural	1.10+	1.06	1.03	1.02
Ages 65-79, urban	1.14*	1.07	1.11	1.05
Ages 80+, rural	1.13*	1.08	1.04	1.03
Ages 80+, urban	1.14**	1.08*	1.04	1.02
Women, rural	1.12*	1.06	1.04	1.02
Women, urban	1.11*	1.05	1.04	1.01
Men, rural	1.11*	1.08	1.03	1.03
Men, urban	1.14**	1.09*	1.07	1.06

Table 5 notes: (1) air quality is measured by air pollution level with seven levels from one to seven with higher scores indicating a better air quality.

(2) All OR estimates are based on two-level multivariable multinomial regressions adjusting for the overall human rights index in lifetime plus all covariates listed in Table 1 and GDP per capita at community-level.

(3) DI: Cumulative deficit index. (4) +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

Our study is unique in that it integrates both a life course approach and an ecological framework to examine the potential associations between proxy environments of human rights exposure in different life stages and health and mortality at older ages. This framework has not been frequently used, even in social gerontology.[75] However, it is worthwhile to reiterate that the purpose of the study is not to propose a new framework for constructing human rights indicators. Instead, we use these self-rated proxy measures to approximately reflect the possible environments of human rights and thus quantitatively model these associations with health outcomes. Because the pathways between human rights environments and health and mortality are extremely complicated, there is substantial possibility of interactions with contextual and individual factors at each step, and because there is often a long lag-period between exposure to some environments and later manifestation in measurable health outcomes, the causal relationship between exposure to human rights environments and health condition is not clear-cut.[76] More studies are also needed to validate and establish the validity of our proxy measures of human rights and to verify the findings in various populations. Furthermore, future studies should include more objective measures in addition to self-rated measures so that it may better to capture the human rights environments.

An even more challenging issue is that the relationship between health status and some variables we used as proxy measures of human rights (for example, economic independence) could be bidirectional. Despite

the advances in the study of and advocacy for health and human rights, the nature of these relationships is not fully understood.[77] The study of links between human rights environments and health and mortality among the old-aged population is in its infancy. We hope our exploratory research will encourage more studies in this area to advance the development in human rights indicators and related research.

When interpreting our findings, the following limitations should also be taken into consideration. First, the seven variables we have used are all proxy measures that may not accurately capture the real human rights environments experienced by each respondent in their lifetime. Some of them, especially those measures in childhood, may suffer from recall biases.[78]

Second, although we have included air quality indicated by the reversal of air pollution index to measure the physical environments of the right to clean air, we only included information on most recent exposure. What matters more may not be just the current level of air pollution, but also the cumulative or total exposure.[79]

Third, the cumulative health-deficit index is created based on 39 variables without considering weighted contributions to the index. Recent epidemiological studies call for a consideration of weighting health deficits, although there is little empirical guidance on appropriate weighting strategies at this stage.[80]

Finally, the CLHLS has collected data on older people aged 65 and older only for a short period, which is insufficient for us to capture each individual's long-term trajectory. These limitations might bias our estimates. Further research, with more accurate measurements and applications in other populations, is clearly warranted to verify our findings.

References

1. Universal Declaration of Human Rights (UDHR), G.A. Res. 217A (III) (1948). Available at http://www.un.org/en/documents/udhr/index.shtml.

2. More information available at http://en.wikipedia.org/wiki/human_rights.

3. Office of the High Commisioner for Human Rights, *Note on the work on the use of indicators to promote and monitor the implementation of human rights* (Geneva: OHCHR, 2010). Available at http://www2.ohchr.org/english/bodies/icm-mc/docs/11th/ohchrindicators02062010.doc.

4. World Conference on Human Rights. *The Vienna Declaration and Programme of Action.* (Vienna, Austria: United Nations, 1993). Available at http://www.ohchr.org/EN/ABOUTUS/Pages/ViennaWC.aspx.

5. OHCHR (see note 3).

6. S. Gruskin, E. J. Mill, and D. Tarantola, "History, principles, and practice of health and human rights," *Lancet* 370 (2007), pp. 449-455; and J. M. Mann, L. Gostin, S. Gruskin et al., "Health and human rights," *Health and Human Rights: An International Journal* 1/1(1994), pp. 6-23. Available at http://www.hhr-journal.org/archives-pdf/4065260.pdf.bannered.pdf.

7. D. F. Alwin and L. A. Wray, "A life-span developmental perspective on social status and health," *Journal of Gerontology: Social Sciences* 60B/S2 (2005), pp. 7-14; S.H. Preston, M. E. Hill, and G. L. Drevenstedt, "Childhood conditions that predict survival to advanced ages among African-Americans," *Social Science and Medicine* 47 (1998), pp. 1231-1246.

8. I. A. Lang, D. J. Llewellyn, K. M. Langa, R. B. Wallace, F. A. Huppert, and D. Melzer. "Neighborhood deprivation, individual socioeconomic status, and cognitive function in older people: Analyses from the English Longitudinal Study of Aging." *Journal of the American Geriatrics Society* 56/2 (2008), pp. 191-198; L. Yao and S. A. Robert. "The contributions of race, individual socioeconomic status, and neighborhood socioeconomic context on the self-rated health trajectories and mortality of older adults." *Research on Aging* 30/2 (2008), pp. 251-273; M. Wen, L. C. Hawkley, and J. T. Cacioppo. "Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: An analysis of older adults in Cook County, Illinois." *Social Science & Medicine* 63/10 (2006), pp.2575-2590; S. V. Subramanian, L. Kubzansky, L. Berkman, M. Fay, and I. Kawachi. "Neighborhood effects on the self-rated health of elders: Uncovering the relative

importance of structural and service-related neighborhood environments." *Journals of Gerontology: Social Sciences* 61B/3 (2006), pp. S153-S160.

9. M. Wen and D. Gu, "The effects of childhood, adult, and community socioeconomic conditions on health and mortality among older adults in China," *Demography* 48/1 (2011), pp.153-181.

10. K. Raworth, "Measuring human rights," *Ethics & International Affairs* 15/1 (2001), pp.111-131.

11. Y. Zeng, D. Gu, J. Purser, H. Hoenig, and N. Christakis, "Associations of environmental factors with elderly health and mortality in China," *American Journal of Public Health* 100/2(2010), pp. 298-305; United Nations Population Divison, *World Population Prospects: The 2010 Revision.* (New York: UNDP, 2011).

12. Xinhua, "National Human Rights Action Plan of China" (2009-2010). Available at http://news.xinhua-net.com/english/2009-04/13/content_11177126.htm.

13. Report on indicators for promoting and monitoring the implementation of human rights, U.N. doc. Hri/mc/2008/3, para 24. Available at http://www2.ohchr.org/english/issues/indicators/docs/HRI.MC.2008.3_en.pdf

14. Raworth (2001, see note 10).

15. OHCHR (see note 13).

16. Ibid.

17. Ibid.

18. Ibid.

19. D. R. Boyd, *The environmental eights revolution: A global study of constitutions, human rights, and the environment* (Vancouver, BC: The University of British Columbia Press, 2012).

20. OHCHR (see note 3).

21. O. Solar and A. Irwin, "A conceptual framework for action on the social determinants of health," (Geneva: WHO Secretariat Commission on Social Determinants of Health, 2007), pp. 7-9. Available at http://www.who.int/social_determinants/

resources/csdh_framework_action_05_07.pdf ; L. Hernandez and D. G. Blazer (eds.), *Genes, behavior, and the social environment: Moving beyond the nature/nurture debate* (Washington, DC: the National Academies Press, 2006).

22. See C.E. Finch, and E.M. Crimmins, "Inflammatory exposure and historical changes in human life-spans," *Science* 305 (2004), pp. 1736-1739; Preston et al. (1998, see note 21); and Y. Zeng, D. Gu, and K.C. Land, "The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China," *Demography* 44/3 (2007), pp.497-518.

23. Preston et al. (1998, see note 7); and Wen and Gu (2011, see note 9).

24. Alwin and Wray (2005, see note 7).

25. J. P. Macjenbach, J. G. Simon, C. W. N. Looman, and I. M. A. Joung, "Self-assessed health and mortality: Could psychosocial factors explain the association?" *International Journal of Epidemiology* 31 (2002), pp. 1162-1168; B. Aldabe, R. Randeson, M. Lyly-Yrjanainen et al. "Contribution of material, occupational and psychosocial factors in the explanation of social inequalities in health in 28 countries in Europe," *Journal of Epidemiology and Community Health* 65 (2011), pp. 1123-1131; V. Skalicka, F. van Lenthe, C. Bambra et al. "Material, psychosocial, behavioral and biomedical factors in explanation of relative socioeconomic inequalities in mortality: Evidence from the HUNT study." *International Journal of Epidemiology* 38 (2009), pp.1272-1284.

26. Ibid.

27. I. Kawachi and L. F. Berkman, *Neighborhoods and health* (New York: Oxford University Press, 2003).

28. S. Macintyre, A. Ellaway, and S. Cummins, "Place effects on health: How can we conceptualise, operationalise and measure them?" *Social Science & Medicine* 55 (2002), pp. 125-139.

29. A. Ellaway, S. Macintyre, and X. Bonnefoy, "Graffiti, greenery and obesity in adults: Secondary analysis of European cross sectional survey," *BMJ* 331/ 7517 (2005), pp. 611-612.

30. K. Zhang and Z. Wen, "Review and challenges

of policies of environmental protection and sustainable development in China," *Journal of Environmental Management* 88/4 (2009), pp. 1249-1261; T. Dubowitz, M. Heron, C. E. Bird, et al., "Neighborhood socioeconomic status and fruit and vegetable intake among whites, African-Americans, and Mexican Americans in the United States," *American Journal of Clinical Nutrition* 87/6 (2008), pp. 1883-1891; R. M. Andersen, H. Yu, R. Wyn, et al., "Access to medical care for low-income persons: how do communities make a difference?" *Medical Care Research and Review* 59/4 (2002), pp. 384-411.

31. Kawachi and Berkman (2003, see note 26); Wen et al. (2006, see note 8). M. Wen, C. R. Browning, and K. A. Cagney, "A multi-level study of neighborhood environment and its relationship to physical activity in adulthood," *Urban Studies* 44 (2007), pp. 1-18.

32. Hernandez and Blazer (2006, see note 22); S. Venkatapuram, R. Bell, and M. Marmot, "The right to sutures: Social epidemiology, human rights, and social justice," *Health and Human Rights: An International Journal* 12/2 (2010), pp. 3-16. Available at http://www.hhrjournal.org/index.php/hhr/article/viewFile/365/558.

33. Venkatapuram et al. (2010, see note 35).

34. Y. Zeng and D. Gu, "Reliability of age reporting among the Chinese oldest-old in the CLHLS datasets," in Y. Zeng, D. L. Poston, D. A. Vlosky, and D. Gu (eds.), *Healthy longevity in China: Demographic, socioeconomic, and psychological dimensions* (Dordrech, Netherlands: Springer, 2008), pp. 61-79.

35. M. E. Thompson, G. T. Fong, D. Hammond et al. Methods of the International Tobacco Control (ITC) four country survey. *Tobacco Control 15* (suppl III) (2006): iii12-iii18; U.S. Census Bureau (2002), Survey Income and Program Participation. Available at http://www.census.gov/sipp/

36. Y. Zeng, D. L. Poston, D. A. Vlosky, and D. Gu, *Healthy longevity in China: Demographic, socioeconomic, and psychological dimensions*, (Dordrech, the Netherlands: Springer Publisher, 2008).

37. D.Gu, *General data quality assessment for the 2005 CLHLS wave,* (Durham: Duke University,2007). Available at http://www.geri.duke.edu/china_study/2005_Data%20assessment%20of%20the%20
2005%20wave.pdf .

38. Ibid.

39. Data not shown, but available upon request from authors. Our multiple imputation strategy noted in the method section below show that results are similar when we impute survival status for those lost to follow-ups in 2005 and in 2008, confirming that the re-interviewed sample is similar to the entire sample including those lost to follow-up.

40. G. I. J. M. Kempen and E. Van Sonderen, "Psychological attributes and changes in disability among low-functioning older persons: Does attrition affect the outcomes?" *Journal of Clinical Epidemiology* 55 (2002), pp. 224-229.

41. Zeng et al. (2007, see note 23).

42. Available at http://www.data.ac.cn/zy/english/database.asp.

43. World Health Organization, "Air quality and health in Eastern Europe, Caucasus and Central Asia," Report on the WHO workshop, St. Petersburg, Russian Federation (Copenhagen: WHO Regional Office for Europe, 2003).

44. T. Schikowski, D. Sugiri, U. Ranft et al., "Does respiratory health contribute to the effects of long-term air pollution exposure on cardiovascular mortality?" *Respiration Research* 8/1(2007), p. 20. Available at http://respiratory-research.com/content/8/1/20.

45. L. Ferrucci, A.Turchi, S. Fumagallo et al., "Sex-related differences in the length of disability prior to death in older persons," *Aging Clinical Experimental Research* 15 (2003), pp. 310-314; U.G. Gerdtham and M. Johannesson, "New estimates of the demand for health: results based on a categorical health measure and Swedish micro data," *Social Science & Medicine* 49 (1999), pp.1325-1332; Kawachi and Berkman (2003, see note 26); and Preston et al (1998, see note 7).

46. A. Kulminski, A. I. Yashin, S. Ukraintseva, et al., "Accumulation of heath disorders as a systemic measure of aging: findings from the NLTCS data," *Mechanisms of Ageing and Development* 127 (2006), pp. 840-848; K. Rockwood, M. Andrew, and A. Mitnitski, "A comparison of two approaches to measuring frailty in elderly people," *Journal of Gerontology: Medical*

Sciences 62A/7 (2007), pp. 738-743; A. I. Yashin, K. G. Arbeev, A. Kulminski, et al., "Cumulative index of elderly disorders and its dynamic contribution to mortality and longevity," *Rejuvenation Research* 10/1 (2007), pp. 75-86; A. B. Mitnitski, X. Song, I. Skoog et al., "Relative fitness and frailty of elderly men and women in developed countries and their relationship with mortality," *Journal of the American Geriatrics Society* 35 (2005), pp. 2184-2189; W. B. Goggins, J. Woo, A. Sham, and S. C. Ho, "Frailty index as a measure of biological age in a Chinese population," *Journal of Gerontology: Biological Sciences and Medical Sciences* 60A(2005), pp. M1046-M1051; and D. Gu, M. E. Dupre, J. Sautter et al., "Frailty and mortality among Chinese at advanced ages," *Journal of Gerontology: Social Sciences* 64B/2 (2009), pp. 279-289.

47. D. Gu, "Validity of health deficient index among the Chinese old adults," *Population & Economics* 5(2009), pp. 52-57 (in Chinese).

48. Goggins et al. (see note 41); Gu et al. (2009, see note 41).

49. Gu et al. (2009, see note 41).

50. Ibid.

51. National Bureau of Statistics of China. *China county data (CD).* (Beijing: China Statistics Press, 2003). We did not treat per capita GDP as a proxy measure of human rights since this variable mainly reflects the economic (or social) development of a community, not the condition of human rights. For example, people living in countries with a very high per capita GDP could also face difficulties to support their daily subsistence, whereas some people living in countries with a very low per capita GDP could have sufficient foods.

52. World Bank, *World Bank GNI per capita operational guidelines & analytical classifications* (Washington, DC: World Bank, 2008). Available at http://siteresources. worldbank.org/DATASTATISTICS/Resources/OGHIST.xls.

53. S. Raudenbush, A. Bryke, Y. F. Cheong, R. Congdon, and M. Du Toit, *HLM: Hierarchical linear and nonlinear modeling* (Linvolneoof, IL: Scientific Software International, Inc., 2004).

54. P. Hox, *Multilevel analysis: Techniques and applications* (Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 2002).

55. L. R. Landerman, K. C. Land, and C. F. Pieper, "An empirical evaluation of the predictive mean matching method for imputing missing values," *Sociological Methods and Research* 26/1(1997), pp. 3-33.

56. C. Winship, and L. Radbill, "Sampling weights and regression analysis," *Sociological Methods and Research* 23 (1994), pp. 230-257.

57. S. Raudenbush, A. Bryke, Y. F. Cheong, and R. Congdon. *HLM: Hierarchical linear and nonlinear modeling,* (Linvolneoof, IL: Scientific Software International, Inc., 2009). Available at http://www.ssicentral.com/hlm/index.html.

58. Xinhua (See note 12).

59. J. Liang, J. Bennett, H. Sugisawa, E. Kobayashi, and T. Fukaya, "Gender differences in old age mortality: roles of health behavior and baseline health status," *Journal of Clinical Epidemiology* 56 (2003), pp. 572-582; J. P. Smith and R. S. Kington, "Demographic and economic correlates of health at old age," *Demography* 34/1 (1997), pp. 159-176; and Zeng et al. (2007, see note 23).

60. P. Hunt and G. Backman, "Health systems and the right to the highest attainable standard of health," *Health and Human Rights: An International Journal* 10/1(2008), pp.81-92. Available at http://www.hhr-journal.org/index.php/hhr/article/view/22/106.

61. K. Lu and B. Yu. "The impact of high food prices on poverty in China," *Development in Practice, Special Issue (Global food-price shocks and poor people: themes and case studies)* (2011), pp. 679-690.

62. W. Yip and W. Hsiao, "China's health care reform: A tentative assessment," *China Economic Review* 20 (2009), pp. 613-619.

63. R. Jackson, N. Keisuke, H. Neil, and J. Zhou, "China's long march to retirement reform: The gray and the middle kingdom revisited," (Washington,

DC: Center for Strategic and International Studies; and Prudential Financial, Inc., 2009). Available at http://news.prudential.com/images/65/US%20GOTMK%20English%20Bro%2009%204_3.pdf ; O. De Schutter, Mandate of the special rapporteur on the right to food. Mission to the People's Republic of China from 15 to 23 December 2010: *Preliminary observations and conclusions.* OHCHR. Available at *http://www2.ohchr.org/english/issues/food/docs/CHINA_food_preliminary_conclusions.doc* ; Yip and Hsiao (2009, see note 64).

64. Hunt and Backman (see note 63); D. Gu, and A. D. Vlosky, "Long-term care needs and related issues in China," in J. B. Garner, and T. C. Christiansen (eds.), *Social Sciences in Health Care and Medicine* (New York: Nova Publisher), pp. 51-84.

65. Ibid.

66. R. Smith, "*Editor's choice: The big Idea,*" *British Medical Journal* 312/7037(1996).

67. J. L. Balfour, and G. A. Kaplan, "Neighborhood environment and loss of physical function in older adults: Evidence from the alameda county study," *American Journal of Epidemiology* 155/6 (2002), pp.507-515; and Kawachi and Berkman (see note 26); A.A. Leibowitz, "The demand for health and health concerns after 30 years*," Journal of Health Economics* 33 (2004), pp. 663-671.

68. C. W. Cann, M. C. Cann, and S. Gao, "China's road to sustainable development," in K.A. Day (ed.),*China's environment and the challenge of sustainable development* (New York: M. E. Sharpe, Inc., 2005), pp. 3-34; K.A. Day (ed.), *China's environment and the challenge of sustainable development* (New York, NY: M. E. Sharpe Inc., 2005)

69. Zhang and Wen (2009, see note 29).

70. Gruskin et al. (see note 6); Mann et al. (see note 6).

71. Wen and Gu (2011, see note 9).

72. M. Osler, M. Madsen, A. M. Nybo Andersen et al. "Do childhood and adult socioeconomic circumstances influence health and physical function in middle-age?" *Social Science & Medicine* 68(2009), pp. 1425-1431.

73. J. Liang, J. Bennett, H. Sugisawa, E. Kobayashi, and T. Fukaya. "Gender differences in old age mortality: Roles of health behavior and baseline health status" *Journal of Clinical Epidemiology* 56 (2003), pp. 572-582.

74. J. Feinglass, S. Lin, J. Thompson, J. Sudano et al. "Baseline health, socioeconomic status, and 10-year mortality among older middle-aged Americans: Findings from the health and retirement study, 1992-2002." *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 62 (2007), pp. S209-S217; R. Hoffman. "Does the impact of socioeconomic status on mortality decrease with increasing age?" *Demographic Research* 13(2005), pp. 35-62.

75. Wen and Gu (see note 9).

76. P. Braveman, "Social conditions, health equity, and human rights," *Health and Human Rights: An International Journal* 12/2(2010), pp. 31-48. Available at http://www.hhrjournal.org/index.php/hhr/article/view/367/564.

77. Gruskin et al. (see note 6); Mann et al. (see note 6).

78. C. Benjet, G. Borges, and M. E. Medina-Mora, "Chronic childhood adversity and onset of psychopathology during three life stages: Childhood, adolescence and adulthood," *Journal of Psychiatric Research* 44/11(2010), pp. 732-740.

79. R. Sun and D. Gu. "Air pollution, economic development of communities, and health status among the elderly in urban China," *American Journal of Epidemiology* 168/11(2008), pp. 1311-1318.

80. Rockwood et al. (2007, see note 49).