WHEN I'M 104: THE DETERMINANTS OF HEALTHY LONGEVITY AMONG THE OLDEST-OLD IN CHINA

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Abstract

This study uses the China Healthy Longevity Survey of Oldest-Old to investigate the health status of the oldest-old in China. We found that the different measures of health collected in the survey were only moderately related. That is, there is not a single construct called “health”. We found that work history was modestly related to some measures of health. We also found that childhood health and socioeconomic status were correlated with health even at advanced ages. To the best of our knowledge, this is the first study to examine this connection in developing countries and at such advanced ages.

Forty years ago Lennon and McCartney speculated about what it would be like to be 64. Today it is appropriate to speculate about what it will be like to be 84 and not too far-fetched to contemplate one's state of well-being at 104. Such speculations are particularly relevant in China where the predicted rapid growth of the "oldest-old" (those aged 80 and older) has raised a number of social and economic concerns for individuals, families, and the state. The population of oldest-old is conservatively predicted to increase from about 12 million currently to 27 million in 2020 and about 100 million in 2050 (United Nations 2001). Concern over aging in China is based on the facts that the oldest-old consume a disproportionate share of medical care, social services, personal assistance, and government and private transfers because the ability to lead an active daily life declines and disability rates increase dramatically with age (Zeng et al. 2002).

On a personal and societal level, it is critical to understand not only the numbers of oldest-old but also their health status because "healthy longevity" places less strain upon resources than does "unhealthy longevity". While in developed countries much of the concern about aging focuses on its wider economic impact, in China current concern is more for its impact at the family level because much of the responsibility for caring for the elderly falls on the family rather than on the state (Zimmer and Kwong 2003). Zeng et al. (2002) estimated that 64 percent of 80-89 year olds, 76 percent of 90-99 year olds, and 87 percent of 100-105 year olds reside with their children. The little institutionalization of the elderly is driven by disability and childlessness. However, with large increases in the number of oldest-old expected, there is concern that some of the responsibility for the care of the aged may shift to the state.

Relatively little is known about the health status of the elderly in developing nations and almost nothing about the numbers or health of the oldest-old. One exception is China where an international collaborative study of the oldest-old was initiated in 1997 (Zeng et al. 2001). Our study uses data from this collaboration to investigate different measures of health that may measure "healthy longevity" and the social, behavioral, and economic factors associated with these measures of health. A better understanding of these factors should allow better predictions of the likely impact of the rapid growth of the oldest-old population on private and public resources in China.

Data

The Chinese Healthy Longevity Survey was conducted in 1998 in 631 randomly selected counties and cities in 22 provinces which are predominantly Han Chinese. This sampling strategy was chosen because age reporting, particularly at older ages, among Han Chinese is very accurate (Coale and Li 1991. Zhenglian et al. 1997). The survey collected extensive demographic, socioeconomic, health, and lifestyle data on those aged 80 and above. Because Zhenglian et al. (1997:94) found that age reporting among semi-super and super-centenarians is questionable, we restrict our study to those between 80 and 105 years of age. Ninety three percent of the sample is Han, 4.4 percent Zhuang, and 1.3 percent Hui. For a detailed description of the data and sampling procedures see Zeng et al. (2001 and 2002).

Measures of Health

There is no universally agreed upon measure of health status because health is generally not directly observable. As Miller (2001:215) observed, "defining health status…is a daunting task." Health status is often thought of as a multidimensional concept which "reduce(s) to a single statistic or two only with great difficulty" (Murray 2000:512). Various measures of health have been used by researchers in the literature both at micro-level and macro-level of analysis. Generally speaking, health measures can be roughly categorized in three dimensions: subjective/objective; physical/psychological; global/specific. However, these three dimensions are often intertwined.

Subjective measures of health (self-rated health) represent subjective feelings about wellness or illness which are generally obtained by asking subjects to rate their own health conditions. Examples of self-rated health include self-rated global health (e.g., Lynch 2003), subjective quality of life (Barr et al. 2002), subjective life expectancy (e.g., Hamermesh 1985). Self-rated health is not an absolute standard but rather a relative measure where current health is correlated to health in the recent past (Lynch 2003), which means health status is dynamic through life-cycle and there may be autocorrelation in self-rated health. Many researchers agree on the validity of self-rated health as a health measure because they have found that self-rated health is highly correlated with objective measures, clinical measures of morbidity, and it is a good predictor of mortality (Geronimus, et al. 2001; Lynch, 2003; Farmer and Ferraro, 1997; Idler and Benyamini, 1997; Schoenfeld et al. 1994, Dwyer and Mitchell 1999). Objective health measures refer to health conditions which can be observed externally or diagnosed by health providers. Commonly used objective health measures include the presence of chronic

diseases, functional limitations (disabilities). However, in studies the objective measures were often reported by the survey interviewee thus took a form of self-rated health (e.g., House et al., 1994).

Most health studies include only some physical health measures, such as functional limitations, chronic conditions, physical fitness (Malina, 2001), Body Mass Index (Murray 2000), or adulthood height (Murray 2000), although a few also include measures of psychological health, such as depression (e.g., Lennon, 1994; Karasek, 1990). Among the physical health measures, functional limitations and chronic conditions are most often used. Functional limitations include three types of disabilities, namely disability in work, in mobility and in personal activities (e.g., Geronimus, 2001). Chronic conditions generally cover the most common health problems that threaten survival, function, and quality of life: heart disease, high blood pressure, lung disease like emphysema or lung cancer, breast cancer, any other type of cancer, diabetes, arthritis or rheumatism, osteoporosis (brittle bones), allergies or asthma, and ulcers, ulcerative colitis, or other digestive problems. Introducing psychological well-being into measures of health contributes to the literature on health measures by focusing researchers' attention on psychological health issues. However, it confounds the study of health effects because depression and other psychological well-beings lead to physical ailments (Hayward 2000).

Global health measures refer to a composite measure containing information on different aspects of a person or a group of persons' health status, for example, global self-rated measure of overall health status, a person's number of chronic conditions, or an index formed from several health measures (Ross and Mirowsky 2001; Ross and Wu

1995). In contrast, specific health measures are used to probe the effects on specific diseases, impairments and disabilities (Hayward et al., 2000).

In this study, we employed six measures of health: self-reported health (selfhealth); Activities of Daily Living (ADL); chronic conditions (diseasestatus); self-reported quality of life (selfqol); objective health status (intvhealth); and the number of times an individual has suffered from serious illness during the past 2 years (illness). The question "How do you rate your health at present?" was addressed to each subject to assess their self-reported health. The respondent chose one of the following answers: "very good", "good", "so-so", "bad", or "very bad". Since there were only a small percentage of people reported "very bad" (0.57%) and "bad" (8.43%), we combined these two groups and formed a four-point self-reported health measure. Zeng et al. (2002:264) use self-rated health to study this population because it has been shown to be "a valid measure of the respondent's objective health status and a strong independent predictor of health longevity" (p.264). Dwyer and Mitchell (1999) used a number of different measures of health in a study of older Americans and also found that a subjective measure of global health was strongly correlated with the presence of health conditions such as neoplasms, circulatory conditions, respiratory problems and the like but not with functional status variables (ADLs). They found ADLs to be correlated with subjective reports of work limitations. They concluded that global self-reports of health and ADLs appear to be measuring different aspects of health status.

However, self-reports may be problematic since they may not be comparable across individuals and may not be independent of context. Individuals may have difficulty in interpreting questions on functional limitation or may have different

perceptions of what constitutes a critical threshold in defining impairment. Zhenglian et al. (2001) conjectured that the meaning of "serious disease" for centenarians may differ between Hangzhou and Beijing. Measurement error results from these problems. This is not a serious problem in linear models where health is the dependent variable but is of real concern in non-linear models such as those estimated in this study. In any regression-style model, measurement error can lead to downward bias in the impact of health when the variable measured with error is used as an independent variable. These issues may be less of a problem in the current study because we control for personality, which is likely to be the primary reason for interpersonal differences in self-reports. We also control for region of birth which may capture differences in interpretation such as those suggested by Zhenglian et al. (2001) and differences in the supply of health facilities that may lead individuals to be more aware of health conditions. Economists have argued that self-reports of health used in the context of studying labor supply are endogenous because ill-health is an acceptable reason for not working (Parsons 1982, Bound 1991, Waidmann et al. 1995, Kreider 1999). That is, reports of ill-health are used to justify withdrawing from the labor force or applying for disability benefits. Endogeneity leads to bias in the estimate of the impact of health on other variables, such as retirement, and of any variable correlated with health. Such concerns are much less likely in the current study since the respondents are well beyond normal working age and there is no need to justify retirement.

Measurement of Activities of Daily Living (ADL) indicates an individual's functional capacity with respect to eating, dressing, getting in and out of a bed or chair, using the toilet, bathing, and continence (e.g., Katz et al. 1983; Zeng et al. 2002).

Respondents were asked whether they have difficulties in (1) bathing, (2) dressing, (3) toilet, (4) transfer, (5) continence, and (6) feeding. Various ADLs are collinear to some degree because of co-morbidity which, in older populations, often occurs as a multiplicity of disease conditions rather than as a single form of co-morbidity (Kaplan et al. 1999). This collinearity suggests some form of combination of ADLs into more compact measures. We follow the suggestion of Zeng et al. (2002) who classified an individual as "active" if he or she needs no assistance in any ADL; if one or two activities need assistance, he or she is classified as "mildly disabled"; if he or she needs assistance in at least three of these ADLs, the individual is classified as "severely disabled". They use ADLs as an indicator of functional capacity because they are "a reasonable proxy of health status, and a key element in attempts to measure quality of life" (p.264). ADLs are also closely related to care giving needs and health care use. To check that this aggregation does not affect our results, we also estimate our regression equation as a simple count of the number of ADLs that are impaired using Poisson and negative binomial assumptions.

The measurement of chronic conditions is based on the respondent's answer to the question "Are you suffering from any of the following (chronic diseases)" and "disability in daily life (due to the chronic disease)". The types of chronic diseases listed in the survey include: (1) hypertension, (2) diabetes, (3) heart disease, (4) stroke, cerebrovascular disease, (5) bronchitis, pulmonary emphysema, asthma, pneumonia, (6) pulmonary tuberculosis, (7) cataract, (8) glaucoma, (9) cancer, (10) prostate tumor, (11) gastric or duodenal ulcer, (12) Parkinson's disease, (13) bedsore, and (14) others. The respondent is classified as "well" if none of the above chronic diseases caused disability

in daily life; if he or she suffered disability from any chronic disease, the individual is classified as "mild chronic condition"; "severe chronic condition" refers to an individual who suffered disability from two or more chronic diseases. To test that this aggregation does not affect our results, we also estimate the chronic disease regression by OLS and as a Poisson and a negative binomial model.

Self-reported quality of life is measured by asking the respondent "How do you rate your life at present" in terms of "very good", "good", "so-so", "bad", and "very bad". Only a small percentage of people reported "very bad" (0.21%) and "bad" (2.83%), so we combined these two groups and formed a four-scale measure of quality of life. The respondent was also asked whether and to what extent they suffered from the serious illness in the past 2 years. The survey question was " how many times have you suffered serious illness which required hospitalization or caused you to be bedridden at home in the past 2 years?" The individual was classified as "no serious illness" if he or she answered no serious illness; "some serious illness" if he or she reported some serious illness but not causing them to be permanently bedridden; and the individual was classified as "bedridden all year around" if that was the response given.

At the end of the survey, the interviewer was asked whether "the interviewee was: 'surprisingly healthy (almost no obvious ailments); or 'relatively healthy (only minor ailments)'; or 'moderately ill (moderate degrees of major ailments or illnesses)'; or 'very ill (major ailments or diseases, bedridden, etc.)". This measure of health status was thus based on the interviewer's assessment of the respondent's health status.

The majority of measures of health refer to prevalence or incidence but provide little information on severity. The count measures for ADLs and chronic diseases used

here do capture severity to some extent. Because of co-morbidity, people with more severe symptoms tend to score higher on counts of ill-health conditions and ADLs (Dwyer and Mitchell 1999).

The distribution of the different health measures is shown in Table 1. Almost two-thirds of respondents report no ADL constraints and ninety percent report no serious illnesses, although over half report at least one or more chronic diseases. Although 57% report that their health is good or very good, 74% report that their quality of life is good or very good. Clearly, while good health is valued it is not a necessary prerequisite to having a good quality of life, and this may speak to respondents' expectations about their health status.

We investigated the correlation structure of the six measures of health used in this study to see if they could be combined to constitute a single measure of health status. The correlation structure and results of a factor analysis are shown in Table 2. In general, the correlations among the various measures are low. The correlations among the more objective measures are 0.2 to 0.3 and the correlation between self-rated health and quality of life is 0.43. Clearly, respondents value more than just good health. The correlations between quality of life and objective measures of health are very low. Thus, respondents' quality of life is affected more by their subjective evaluation of their health than by more objective evaluations of it. Based on the correlations, it appears that the interviewers weigh both objective measures of health and the respondent's own evaluation in forming their view of the respondent's health. The correlations also support a statement made by Zeng et al. (2002:268) in their study of the same population we have studied. They concluded that "exceptionally long-lived people are likely to consider health to be good

and view life as satisfactory, relatively independently of their capacity to perform daily activities." The correlation between ADL and self-reported health is 0.25 and that between ADL and self-reported quality of life is 0.03 (Table 2).

The first eigenvalue is only slightly greater than one and no other eigenvalue is greater than one, so the evidence to suggest a single health measure is weak. Only respondent and interviewer global health reports have factor loadings of 0.6 or above, generally taken as the cut-off level to be considered as loading on a factor. Rotation does not improve the fit to the data. There is only modest correlation between respondent's self-report and more specific health conditions and ADLs. The latter result is similar to that found by Dwyer and Mitchell (1999) for a younger U.S. sample but the former result differs. The low correlation between all measures and the self-reported quality of life is surprising and is inconsistent both with findings that nonfatal diseases and impairments can have significant consequences for quality of life (Hayward et al. 2000) and with the link between ADLs and quality of life assumed by Zeng et al. (2002). Our findings suggest that the respondent's reported quality of life is not closely related to their health status. The results of this exercise suggest that the different measures of health collected in the survey capture different aspects of health status and that they cannot be combined into a single measure of health.

Factors Associated with Healthy Longevity

Work history may affect morbidity and mortality through the type of work performed, the working conditions, or the fringe benefits associated with work, such as access to health care facilities or health insurance. Early studies of the effects of work on

morbidity or mortality estimated occupational effects and assumed that any such differences are due to differences in the physical conditions encountered in different occupations such as pollution or risk of occupational injury. However, a more nuanced view is now taken. Occupations can differ on complexity (creativity, autonomy, and cognitive-skill demands), physical and environmental demands, social skill demands, and manipulative skill demands (Moore and Hayward 1990, Karasek 1990, Marmot et al. 1997, Hayward and Gorman 2004). Job complexity and job control emerge as having positive effects on health. It is also possible that occupation proxies for lifetime earnings (Zissimopoulus and Karoly 2003). Since desirable aspects of jobs such as complexity and control tend to be positively correlated with earnings, without accurate measures of income, which are lacking in the Healthy Longevity Survey, it is not possible to distinguish between these different impacts of occupation.

In this study we investigate the effects of work through two variables in addition to a set of occupational dummies. Respondents were asked whether they had ever undertaken any physical work and, if so, when they started and when they stopped. A dummy variable was created for ever did physical work and a continuous variable for years of physical work was constructed. The occupational categories were: professional or government (7.4%), industrial (6.8%), commercial or service (9.1%), military or other (2.2%), housework (19.3%), and agriculture, forestry, or fisheries (55.2%, the excluded category in the regressions).

Childhood Influences on Healthy Longevity

A growing body of research suggests that adult morbidity is related to childhood life circumstances (in utero environment, nutrition, exposure to infectious diseases and

environmental toxins, social and economic deprivation). See, for example, Elo and Preston (1992), Fogel (1993), Kuh and Ben-Shlomo (1997), Hayward et al. (2000), Blackwell et al. (2001), and Hayward and Gorman (2004). Initially, the effects were thought to be indirect and negative: childhood socioeconomic status (CSES) affects adult SES (ASES) which directly affects health (Kuh and Wadsworth 1993). Haywood and Gorman (2004) suggest that CSES can also affect education and that CSES and education shape preferences for major lifestyle behaviors such as smoking, drinking, diet, and exercise which affect health. Recent research has suggested that there may also be direct effects of childhood health even after CSES and ASES are controlled for. A number of studies have found that poor childhood health was associated with higher prevalence of specific health conditions such as cancer, lung disease, cardiovascular conditions, and arthritis/rheumatism controlling for CSES and ASES (Kuh and Wadsworth 1993, Martyn et al. 1996, Blackwell et al. 2001). Blackwell et al. (2001) found that the type of childhood illness differentially affects adult health. What matters most are infectious diseases. The importance of these findings is that health care policies targeted at children can have considerable long-term benefits for adult health.

We capture childhood health and socioeconomic conditions with a number of variables. Respondents were asked whether they were sick enough as a child to require care (childhood illness) and whether they went to bed hungry as a child (nutrition). These variables were coded one if the answer was "yes". Almost half of the sample reported being sick enough in childhood to require care and 56 percent reported that they often went to bed hungry when a child. We also included a variable for the respondent's parity. A number of studies in developed and developing countries have found that later

children received a smaller share of household resources than earlier children because of constraints on household resources and they may suffer higher morbidity as a consequence. However, in China it is hypothesized that the youngest child is favored and may receive more resources than older siblings. There may also be in utero parity effects. Childhood SES is proxied for by father's occupation. Preston and Haines (1991) found that rates of infant mortality in the U.S. in 1900-1910 were lowest in households in which the father was a farmer or a salesman and in which at least one parent was literate. We lack information on other potentially useful measures of CSES, such as parent's education and childhood household income. We do, however, have information from the respondent as to whether they received inadequate care when sick as a child. Fully 16.5 percent of respondents had been sick enough as a child to require care but did not receive it. This variable should indicate a deprived childhood, either socially or economically, or residence in an area that lacked medical facilities. In an effort to control for the latter possibility we include a set of region of birth dummy variables and a urban/rural dummy variable.

Regional dummies may capture differences in socio-economic factors and differences in the interpretation of the health questions between areas. As noted above, Zhenglian et al. (1997:101) suggested that the interpretation of what is a "serious" disease may differ between Hangzhou and Beijing, the two areas used in their study of centenarians. In this study they found no clear association between density of centenarians and socio-economic development level and concluded that the socio-economic and environmental factors affecting longevity in China remain "an open question" (p.98). There may be urban/rural differences in the disease environment, so we

include an urban/rural dummy variable. In their study of the U.S. at the turn of the 20th century, Preston and Haines (1991) found higher infant mortality rates in urban areas, so we expect higher morbidity levels in respondents who grew up in urban areas.

Demographic and Personal Factors

A number of other factors may affect longevity and are controlled for in our study. Health declines with age and may do so "quickly" for ADLs for the oldest-old and "slightly or moderately" for their self-rated health (Zeng et al. 2002). Zeng and Vaupel (2002) found that satisfaction with current life was almost unchanged between ages 80 and 94 years but declined slightly after that. Thus we add an age variable to our regression equations and also test for non-linear age effects by including age squared. Zeng et al. (2002) also find the health of oldest-old men to be better than that of women and speculate that this could reflect the fact that men work outdoors and therefore increase their capacity for maintaining the capabilities of daily living. It is also possible that the male advantage comes from higher education, pension, and income or adverse selection of more frail males.

Education may affect health through its impacts on risk taking, deferring gratification, and sense of control over one's environment (Preston and Elo 1992) or through its impact on preferences for lifestyle behaviors and its impact on adult socioeconomic achievement (Haywood et al. 2000). Our sample exhibits very low levels of education are similar to those reported by Zhenglian et al. (1997) for centenarians. Almost two-thirds of respondents had no formal education and 14.7 percent had one to three years of education. Such low levels of education reflect the paucity of educational

facilities and opportunities that existed seventy or more years ago, particularly in rural areas (Zeng et al. 2002). We use a set of dummy variables to measure education. The categories are: zero (excluded category), few years (1-3 years), some (4-6 years), more (7-9 years), and well-educated (10 or more years).

We also control for a number of lifestyle variables that have been found to be related to health. We control for ever smoked, ever drank, and ever exercised. Smoking has negative implications for morbidity and mortality (Rogers et al. 2000). In this study we use a dummy variable which equals one if the respondent ever smoked. Almost one-third of respondents had smoked at some stage in their life. Existing evidence suggests the possibility of a non-linear relationship between alcohol consumption and health (Rogers et al. 2000). Non-drinkers and heavy drinkers exhibit higher levels of morbidity. We use a simple dummy variable for ever-drank (35% of the sample drank at some stage in their life) and also use a set of dummy variables to test for a non-linear relationship (never drank, 66%; consume one to three drinks per day, 27%; and consume four or more drinks per day, 8%). Physical fitness is associated with lower levels of cardiovascular morbidity and mortality, reduced risk for several cancers, and affords some protection against other independent risk factors for all-cause and cardiovascular mortality (Malina 2001). We use a dummy variable which equals one if the respondent currently or ever exercised.

Although there is some debate about the impact of marriage on health, most studies find marriage to be positively associated with health (Lillard and Waite 1995, Rogers et al. 2000, Murray 2000). Only about one percent of respondents did not marry, so it is unlikely we will find any effect of having ever married. The survey asked

respondents if their marriage had been “happy”, “so-so”, or “bad”. If there is an effect of marriage on the morbidity of the oldest-old, we would expect to find lower morbidity and higher reports of quality of life among those who report being happily married.

Few studies of health investigate the impact of personality on health. An exception is Hayward et al. (2000) who suggested that significant differences between blacks and whites on satisfaction with friends and financial situation and on a depression scale may contribute to racial differences in health. The Healthy Longevity Survey asked seven questions related to the respondent’s personality. We factor analyzed the responses and all load with a factor loading of 0.79 or more on a single factor. We combine these variables with equal weights to construct a personality index and expect that people with a more positive personality will report better health and quality of life.

Although longevity is moderately heritable in human populations (McGue et al. 1993, Ahlburg 1998, Mitchell et al. 2001), longevity is thought to contain only limited information on functional status, since some individuals can exhibit healthy functional survival but others disability-associated survival (Hadley 2000). However, Duggirala et al. (2002) have shown that at least one measure of biological aging in the Mennonite population has substantial genetic determinants. The Healthy Longevity Survey asked respondents if their parents were still alive and, if not, their age at death. Unfortunately, about one-third of the observations on parent’s age at death are missing. Despite this limitation, we attempted to test for an association between parent’s longevity and the respondent’s health by including variables for mother’s and father’s age at death and dummy variables for missing values of these variables.

Results

We find only modest support for the hypothesis that healthy longevity is related to work history, at least among the oldest-old. Whether a respondent has ever engaged in physical labor is positively associated with better ADL status (at the 0.01 level), self-reported health (at the 0.10 level), and interviewer rating of health (at the 0.06 level) but is not associated with the other three, arguably more objective, measures of health. It could be that physical work "hardens" the individual and protects them from health insults or it could be that selection is operating. That is, only the hardiest survive physical labor and report relatively good health at advanced ages. When we added a measure of the number of years a respondent had done physical labor, the duration variable was positive and significant for most of the health measures and the variable for ever engaged in physical labor was now negative and significant for three of the health measures. When the duration variable was broken down into a series of dummy variables measuring work duration in decades, we found that the duration result was driven by the 13 percent of the sample who reported working 60 years or more. It is highly likely that the duration effect reflects causation from health to work not from work to health. That is, only those who are healthy can work for very long durations. We attempted to instrument for work duration using the age at which the respondent first started physical work but the instrument was not significant in any of the health regression equations. Either this is a poor instrument or the duration of work has no effect on health.

There are significant differences in several measures of health associated with different occupations. Professional and government workers report worse ADL status, and more diseases and illnesses than those who worked in agriculture, forestry, or

fisheries. Industrial workers report worse ADL status and more diseases, commercial and service workers report fewer illnesses, military personnel report more diseases, and those who worked in the household report worse ADL status. It is interesting to note that these occupational differences in more objective measures of health do not translate into worse subjective reports of health or quality of life. As noted above, it is not clear whether these differences reflect occupational differences in working conditions, income, or occupation-related differences in access to health care. The relatively better health of primary-sector workers could reflect better nutrition due to better access to food.

Being sick as a child or going to bed hungry does not appear to affect adult health, at least among the oldest-old. However, not receiving adequate care when sick as a child is associated with poorer health at older ages and is statistically significant for all health measures except interviewer reported health. This finding could reflect either economic deprivation in childhood or a lack of local medical facilities. The regional and urban/rural dummies should control to some extent for differences in the availability of facilities. Birth parity is not related to health, except in the case of respondents who were fourth and higher order births. These individuals report better global health and quality of life. Further support for the importance of childhood SES comes from health differences related to father's occupation. Children of farmers, foresters, and fishermen tend to have better ADL status and fewer diseases. The one exception is children who reported their father's occupation as "housework"; they tend to report better health.

A number of personal characteristics are associated with some measures of health status at advanced age. Like Zeng et al. (2002), we found that ADL status declines with age but we did not find evidence of non-linear decline. Nor did we find a significant

effect of age on self-reported health. Two other significant age effects were found, a significant negative association with interviewer rating and a positive association with self-reported quality of life, although the latter association was negative and insignificant in a regression including only age and sex. No non-linear age effects were found for these other health measures. Unlike Zheng and Vaupel (2002), we did not find a decline in reported quality of life after age 94. In fact, we found those over 94 years to report a better quality of life. We did find those over 94 years to report fewer ADLs and more illnesses and interviewers to rate their health as poorer than younger respondents.

In general, males reported better health than females but males reported lower quality of life than did females, although the latter association is positive and significant in a regression including only age and sex. The better educated had higher self-reports of health and quality of life than the less well-educated. Interviewers also rated the health of the more educated to be better. As noted above, the channels through which education is assumed to work, lifestyle choices, adult SES, and personality are controlled for here, so the impact of education is in addition to any affect through these channels. We investigated the relationship between education and lifestyle to see if education might be operating through these indirect channels. In this sample, the relationship between education and behaviors is not linear. Only 24% of those with no education smoked compared to 50% for those with less than 10 years of education and 42% of those with 10 or more years of education. One-third of those with no education or 10 or more years drank compared to about 50% for the other education groups. The strongest association between education and behavior is for exercise. Only 26% of those with no education

exercised while 84% of the most educated exercised. If education has an indirect effect through lifestyle, it is most likely to be through its effect on exercise.

A number of studies have suggested that some personal characteristics may modify the impacts of other variables. For example, Zeng et al. (2002) suggest that sex effects may vary with age and that the effects of education may vary between rural and urban areas. Lynch (2003) found that the relationship between health and age strengthened with age. We added age/education, age/sex, and urban-rural/education interactions to our basic model but found no evidence to support such interactions.

Almost all Chinese people married in the period under study. The very few who did not and survived to old age reported similar health status to that of their married peers. We found that reporting that your first marriage was a "good" marriage was associated with better reported health and the effects on respondent and interviewer global health were statistically significant. Smoking was associated with poorer health but the effect only approached statistical significance for self-reported health ($p=.08$). Drinking (either in linear or non-linear form) was not associated with health at older ages but exercise was. It seems that the adverse effects of smoking and not drinking or drinking to excess may be felt at earlier ages, removing these individuals from the land of the living. Those who survive to very old ages seem to be little affected by life style choices with one very important exception. Exercise may impart benefits on more objective measures of health status (ADLs, illnesses) and on global reports of health and well-being. However, reverse causation is also a possibility because those who are healthy are more able to exercise. A positive personality appears to be good protection against the ravages of time. Irrespective of the specification of the model or the

estimation technique, those with an optimistic personality not only reported a more positive outlook on their health and quality of life but they also reported fewer ADLS, diseases, and illnesses. This could be because they set a higher threshold for what constitutes a "disease" or "impairment" or it could be that a more positive outlook somehow mediates other factors that can lead to poorer health. As with exercise, reverse causality cannot be ruled out. It is probably easier to have a positive outlook if you are not ill.

Our attempt to uncover an intergenerational link between parent's longevity and the respondent's health was unsuccessful. No systematic pattern in the coefficients was observed and none were statistically significant. It could be that this failure was due to the large amount of missing data in the survey. Respondent's born in urban areas tended to report more ADLs, diseases, and illnesses but they also tended to give higher self-reports of health status. However, none of these effects were statistically significant. While there were a number of significant coefficients on individual place of birth dummy variables, no consistent pattern of effects was observed. It seems that by the time a respondent had survived to very old age whatever factors were associated with their place of birth were no longer important.

Finally we checked the robustness of our findings to different estimation approaches. We re-estimated the ADL and disease regressions by ordinary least squares, ordered probit (without grouping responses), and as count models (Poisson and negative binomial). Our results were robust to estimation technique.

Conclusions

The Healthy Longevity Study collected data on six measures of health employed in this study. The correlations among the different measures were quite low and there was little statistical support for combining these measures into a smaller number of measures of "health". We agree with Murray's conclusion that health is a "multidimensional concept". The measures did not break down into a simple pattern of "more objective" measures such as ADLs, number of diseases, and number of illnesses, and "more subjective" self-reports of global health and quality of life. Although the effects of some variables tended to be similar for the more objective measures or the more subjective measures, this was not always the case. That is, the oldest-old in China exhibit different forms of "health".

We found only modest evidence to support a relationship between work history and health among the oldest-old in China. Working in a physical job was associated with self-reports of better health and better ADL status. In addition to this, working in the primary sector, agriculture, fisheries, or forestry, was associated with better health as measured by ADLs, disease status, and illnesses but these differences were not reflected in the more subjective measures of health.

To the best of our knowledge, ours is the first study to investigate the impact of childhood health and socioeconomic status in a developing country and to study this relationship for the oldest-old. We found that childhood health and socioeconomic status had independent effects on adult health even at very advanced age and even after controlling for adult socioeconomic status and lifestyle choices. The variable that was most important was whether a child received care for childhood illnesses. Those that did receive care reported better objective and subjective health at advanced ages. The

importance of this finding is that the provision of health care services in childhood can have very long-term returns in the form of improved adult health even at quite advanced ages.

Some other variables that were associated with at least some measures of better health were being happily married and exercising. We did not find that smoking and drinking had adverse health effects at advanced age probably because those most susceptible to these "vices" had already been removed from the population.

Table 1: Distribution of Health Measures

ADL Status	Percent
Severe disability	18.24
Mild disability	18.93
Active	62.83

Disease Status	Percent
Two or more illnesses	23.87
One illness	30.37
Well	45.76

Interviewer health rating	Percent
Very ill	4.27
Moderately ill	11.19
Relatively ill	43.74
Surprisingly healthy	40.80

Self-reported health	Percent
Bad	9.01
So-so	33.94
Good	44.29
Very good	12.76

Illnesses	Percent
Bedridden	4.36
Some serious illness	6.42
No serious illness	89.22

Self-reported quality of life	Percent
Bad	3.01
So-so	23.11
Good	56.10
Very good	17.75

Table 2: Correlation Matrix and Factor Analysis of the Six Health Measures

Correlation Matrix

	ADL status	Diseases	Self health	Self q-o-l	Intrvr health	illness
ADL status	1.0000					
Diseases	0.1956	1.0000				
Self health	0.2541	0.1892	1.0000			
Self q-o-l	0.0285	0.0038	0.4283	1.0000		
Intrvr health	0.5393	0.2627	0.4244	0.1829	1.0000	
illness	0.2927	0.1537	0.1599	0.0368	0.3696	1.0000

	Factor loadings		
	1	2	uniqueness
ADL status	0.54147	-0.25018	0.64
Disease Status	0.32	-0.13	0.88
Self-reported health	0.60	0.30	0.55
Self-reported quality of life	0.32	0.44	0.70
Interviewer health rating	0.70	-0.11	0.49
Illnesses	0.36	-0.17	0.84

Factor Analysis

	(principal factors; 2 factors retained)			
Factor	Eigenvalue	Difference	Proportion	Cumulative
1	1.48285	1.07363	1.0836	1.0836
2	0.40923	0.42165	0.2990	1.3826
3	-0.01243	0.04821	-0.0091	1.3735
4	-0.06064	0.14947	-0.0443	1.3292
5	-0.21011	0.03031	-0.1535	1.1757
6	0.24042		-0.1757	1.0000

Table 3: VARIABLE DEFINITIONS

Variable	Definition	Mean	Std. Dev.
adlstatus	A three-scale categorical variable indicating the individual's ADL ability: sever disable=0; mild disable=1; active=2	1.445883	0.7822618
diseasestatus	A three-scaled categorical variable indicating the individual's health status in terms of chronic diseases: severe chronic disease (2 or more chronic diseases)=0; mild chronic disease condition (1 chronic disease)=1; relative few chronic diseases (no chronic disease)=2.	1.218853	0.8052863
selfhealth	A four-scale categorical variable indicating the individual's self-rated health: value 0 means bad; value 1 means "so-so"; value 2 means good; value 3 means very good.	1.608044	0.8208245
selfqol	A categorical variable indicating the individual's self-rated quality of life: bad=0; "so-so"=1; good=2; very good=3.	1.885746	0.7190732
intvhealth	A four-scale categorical variable indicating the interviewer's rating of the individual's health status "very ill"=0; "moderately ill"=1; "relatively healthy"=2; "surprisingly healthy"=3.	2.210731	0.8039314
illness	A categorical variable indicating the individual suffered from serious illness during the last 2 years before the interview: bedridden all the year around=0; some serious illness=1; no serious illness=2.	1.848551	0.4645775
physlabor	Equal 1 if the individual has done physical labor regularly.	0.7835591	0.4118416
physlabordur	Number of years of physical labor.	42.64654	27.28311
selfoccup1	Equal 1 if the individual's main occupation is professional, technical, or governmental, institutional or managerial personnel.	0.0743896	0.2624187
selfoccup2	Equal 1 if the individual's main occupation is agriculture, forestry, animal husbandry or fishery.	0.5519591	0.4973212
selfoccup3	Equal 1 if the individual's main occupation is industrial.	0.0675752	0.2510298
selfoccup4	equal 1 if the individual's main occupation is commercial or service.	0.0905168	0.286937
selfoccup5	equal 1 if the individual's main occupation is military personnel or other occupation.	0.0228279	0.1493632
selfoccup6	equal 1 if the individual's main occupation is housework.	0.1927314	0.3944663
pateroccup1	Equal 1 if fatherl's main occupation is professional, technical, or governmental, institutional or managerial personnel.	0.0512209	0.2204605
pateroccup2	Equal 1 if father's main occupation is agriculture, forestry, animal husbandry or fishery.	0.7134583	0.4521712
pateroccup3	Equal 1 if father's main occupation is industrial.	0.0295287	0.1692926
pateroccup4	equal 1 if father's main occupation is commercial or service.	0.1267462	0.3327073
pateroccup5	equal 1 if father's main occupation is military personnel or other occupation.	0.0650767	0.2466751
pateroccup6	equal 1 if father's main occupation is housework.	0.0139693	0.1173702
sickaskid	Dummy variable equal 1 if the individual has been sick enough for care as a child.	0.4904451	0.4999373
nocareaskid	Dummy variable equal 1 if the individual did not receive adequate care when sick as a child.	0.1650074	0.3712085

Table 3: VARIABLE DEFINITIONS

Variable	Definition	Mean	Std. Dev.
hungaskid	Dummy variable equal 1 if the individual often went to bed hungry as a child.	0.5611824	0.496271
age	Age	92.03044	7.403183
male	Dummy variable equal 1 if male.	0.402385	0.4904066
noeduc	Dummy variable equal 1 if the individual received no schooling.	0.6705493	0.4700406
feweduc	Dummy variable equal 1 if the individual received 1 to 3 years' schooling.	0.1471965	0.354322
someduc	Dummy variable equal 1 if the individual received 4 to 6 years' schooling.	0.0935252	0.2911836
moreduc	Dummy variable equal 1 if the individual received 7 to 10 years' schooling.	0.0501313	0.2182283
welleduc	Dummy variable equal 1 indicating the individual received more than 10 years' schooling.	0.0385977	0.1926451
eversmoke	Dummy variable equal 1 if the individual has smoked before or smoke presently.	0.3237868	0.4679464
everdrink	Dummy variable equal 1 if the individual drank before or drink presently.	0.3497044	0.4769037
everexercise	Dummy variable equal 1 if the individual exercised before or exercise presently.	0.3479991	0.4763628
birthplc_B~g	Dummy Variable equal 1 if the individual's birthplace is Beijing.	0.0026122	0.0510453
birthplc_T~n	Dummy Variable equal 1 if the individual's birthplace is Tianjin.	0.0085179	0.0919037
birthpl~ebei	Dummy Variable equal 1 if the individual's birthplace is Hebei.	0.0155593	0.1237699
birthp~hanxi	Dummy Variable equal 1 if the individual's birthplace is Shanxi.	0.007155	0.084289
birthplc_L~g	Dummy Variable equal 1 if the individual's birthplace is Liaoning.	0.0319137	0.1757803
birthplc_J~n	Dummy Variable equal 1 if the individual's birthplace is Jilin.	0.0072686	0.0849505
birthplc_H~g	Dummy Variable equal 1 if the individual's birthplace is Heilongjiang.	0.0030664	0.0552936
birthplc_~ai	Dummy Variable equal 1 if the individual's birthplace is Shanghai.	0.0255537	0.1578084
birthplc_J~u	Dummy Variable equal 1 if the individual's birthplace is Jiangsu.	0.1444634	0.3515789
birthplc_Z~g	Dummy Variable equal 1 if the individual's birthplace is Zhejiang.	0.088586	0.2841614
birthplc_A~i	Dummy Variable equal 1 if the individual's birthplace is Anhui.	0.0525838	0.2232137
birthplc_F~n	Dummy Variable equal 1 if the individual's birthplace is Fujian.	0.0437252	0.2044945
birthplc_J~i	Dummy Variable equal 1 if the individual's birthplace is Jiangxi.	0.0149915	0.1215254

Table 3: VARIABLE DEFINITIONS

Variable	Definition	Mean	Std. Dev.
birthplc_S~g	Dummy Variable equal 1 if the individual's birthplace is Shangdong.	0.0658717	0.2480717
birthpl~enan	Dummy Variable equal 1 if the individual's birthplace is Henan.	0.0439523	0.2050007
birthpl~ubei	Dummy Variable equal 1 if the individual's birthplace is Hubei.	0.0333901	0.1796633
birthpl~nnan	Dummy Variable equal 1 if the individual's birthplace is Hunan.	0.0361158	0.186589
birthplc_G~g	Dummy Variable equal 1 if the individual's birthplace is Guangdong.	0.0793867	0.2703567
birthplc_G~i	Dummy Variable equal 1 if the individual's birthplace is Guangxi.	0.1343555	0.3410532
birthplc_S~n	Dummy Variable equal 1 if the individual's birthplace is Sichuan.	0.1032368	0.3042852
birthplc_C~g	Dummy Variable equal 1 if the individual's birthplace is Chongqing.	0.0274844	0.1634993
birthp~aanxi	Dummy Variable equal 1 if the individual's birthplace is Shaanxi.	0.0128336	0.1125627
birth1	Dummy variable equal 1 if the individual's birth order is one.	0.3764045	0.4845117
birth2	Dummy variable equal 1 if the individual's birth order is two.	0.2519897	0.4341808
birth3	Dummy variable equal 1 if the individual's birth order is three.	0.1622191	0.3686733
birth4	Dummy variable equal 1 if the individual's birth order is four or more.	0.1028792	0.3038188
birthurban	Dummy variable equal 1 if the individual's birthplace is urban area	0.1500795	0.3571696
personality	A composite variable showing the extent that the individual is optimistic	3.15366	0.5813248

Table 4: Regression

Variable	adlstatus	Diseasestatus	selfhealth	selfqol	intvhealth	illness
physlabor	.11443438**	0.01538108	0.06275776	0.00848542	.0761129*	-0.04345021
selfoccup1	-.23706785***	-.30828306***	-0.08446365	0.12443476	-0.09989057	-.23129952**
selfoccup3	-.16070045*	-.25233904***	-0.08495997	-0.0094578	-.08688565*	-0.13273375
selfoccup4	-0.10317745	-0.0498633	0.04060796	0.01072557	-0.00258105	-0.15337568
selfoccup5	-.16274284*	-.30817824***	0.02352638	-0.12149533	0.00561081	-0.13808528
selfoccup6	-0.11369086	0.01733388	0.06409265	.10830498*	-0.01798389	-0.05886846
pateroccup1	-0.13836279	-0.12510203	-0.06057382	0.01665897	0.06688729	-0.08686012
pateroccup3	0.02771534	-0.07471158	-0.05204928	-0.0479767	-0.03111928	0.01137216
pateroccup4	0.00321392	-.07436505*	-0.03366507	0.01530475	0.0666838	0.05448091
pateroccup5	-.15877465*	-0.02031907	-0.07987504	0.01618232	-0.02696039	-.20952001***
pateroccup6	0.03443157	-.23060051*	0.31985862	0.10846765	.26975297*	.69876054*
sickaskid	0.00024065	-0.02963265	-0.00843034	.11688892*	-.07609957*	-0.01048189
nocareaskid	-0.15292707	-.09211932**	-.15483098***	-.16047704**	-0.05196024	-.17611526**
hungaskid	-0.00586154	0.03124543	-0.02479999	-0.00888381	-0.02105642	-0.02619609
age	-.06246321***	0.00283112	-0.00133519	.00725836**	-.02519194***	-0.0040947
male	.20816913***	.25838028***	.09509234***	-.09031418*	0.09226848	0.0342565
feweduc	0.02496834	-0.02187834	0.06800049	0.05652036	.09747569*	0.01094348
someduc	-0.04673886	-0.03702592	.118278***	.09871488**	0.11661076	0.03245636
moreduc	-0.01245977	0.03294007	.15996994***	0.10225321	.15550857**	0.0084046
welleduc	-0.14356675	-.23309361*	-0.14318529	0.11405427	-0.12327673	-.26891524**
eversmoke	0.03353441	-0.02062242	-0.05511126	-0.02301802	-0.02415981	-0.05767566
everdrink	0.01214205	-0.0238581	-0.01479583	0.04180474	0.03402094	-0.02910337
everexercise	.17390075***	-0.01119516	.12604684***	.16275753***	.27994763***	.1469485*
birth1	-0.08332898	0.02163527	0.07166662	0.02526822	-0.07711352	-0.07109652
birth2	-0.06946054	-0.06230976	0.05728557	0.01435606	-0.06784093	-0.03940256
birth3	-0.06219678	-0.01232482	0.07927965	0.02425567	-0.04300071	-0.06832348
birth4	-0.09102372	0.02544141	.18861074***	.14376175**	-0.01275104	-0.13882578
birthplc_B~g	-.4465842***	-.2246737**	-.18399049*	0.05260831	-.28716621**	0.04887104
birthplc_T~n	-.4301506***	.2255464***	0.04320176	.13456846***	0.10523994	-.21414783**
birthpl~ebei	-.50190717***	-0.02965273	.24092977**	.39481734***	0.01804974	-0.14153265
birthp~hanxi	-.48668639***	.35885247***	.26113612**	-0.05394866	-0.0453946	-0.01703642
birthplc_L~g	-.45478288***	0.02201971	.32885953***	.30582257***	0.0472029	0.14508058
birthplc_J~n	-.54042869***	.42230676***	-0.01446104	-.08475558*	0.1792248	-0.13393639
birthplc_H~g	-.75294129***	0.09210171	.28109657**	.15799742***	-0.0072256	-.24090714**
birthplc_~ai	-.24233925***	0.0587079	0.15238584	.24657656***	-0.12725202	0.02451968
birthplc_J~u	-.16129458**	.44191213***	.21350753*	.11414348***	0.12569528	0.1061898
birthplc_Z~g	.27120428***	.30462233***	.22382133*	-.10501566**	.29790179**	.34373914***
birthplc_A~i	-.34694758***	.23310848***	-.22793449*	-.38728138***	-0.15309271	0.04856219
birthplc_F~n	.19473392***	.2871321***	.19845672*	-.17167027***	.37849606***	.28381208***
birthplc_J~i	.31558121***	.16335617**	-0.0202918	-.21852083***	0.04765752	0.13321551
birthplc_S~g	-.46227894***	.27440958***	.41169476***	.40008462***	0.05224378	0.02526208
birthpl~enan	-.27297941***	.26996107***	.4188132***	.37796375***	.30646915**	.24066673**
birthpl~ubei	.20577536***	.57408968***	.21959247*	-0.01523237	.31889704**	.39310127***
birthpl~nnan	.13081279*	.5086916***	-0.11361856	-.33498827***	.33970067***	-0.01776033
birthplc_G~g	.24563927***	.31813609***	.22790798*	-.1692822***	-0.07769704	.16765389*
birthplc_G~i	.37613035***	.51834263***	.252106**	-.16539039***	.29042645**	.41787306***
birthplc_S~n	-0.0516066	.42560993***	-0.01263043	-.22235384***	0.04570407	0.01624262
birthplc_C~g	-0.10317245	0.04182169	-.17981806*	-.59751873***	0.18198677	-0.00887575
birthp~aanxi	-.55078732***	-.27846069***	-.18876691*	-.11940698***	-.23542801*	-0.07419592
personality	.32268855***	.21070579***	.65494776***	.5593243***	.5033096***	.15334519***
birthurban	-0.06102014	-.11477274*	0.01087465	0.03263241	0.01667086	-0.04211749
_cut1	-5.948543***	0.46098853	.70303108*	0.42910126	-2.6861404***	-1.8840849***
_cut2	-5.1975434***	1.2934814***	2.0174817***	1.8085369***	-1.8276388***	-1.2862928**
_cut3			3.477615***	3.5279465***	-0.30773237	
legend:	*	p<0.05;	**	p<0.01;	***	p<0.001

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