Psychological Resilience and the Onset of Activity of Daily Living Disability among Older Adults in China: A Nationwide Longitudinal Analysis

Yiqing Yang and Ming Wen

Department of Sociology, University of Utah

Correspondence should be addressed to Yiqing Yang, Department of Sociology, University of Utah, Salt Lake City, UT 84112-0250. E-mail: yiqing.yang@soc.utah.edu.

Abstract

Little research has explored the influence of psychological resilience on the onset of Activity of Daily Living (ADL) disability in the developing countries and no interaction effect of resilience with age on disability is tested in the literature. Using a sample of 11,112 older adults from two waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) (2002-2005), the current study finds that higher levels of psychological resilience (measured by a five-item scale) at the baseline are significantly associated with reduced risk of becoming ADL disabled during the 3-year follow up period, independent of socio-demographic characteristics, family support, and health status. Moreover, this association varies by age. Higher levels of resilience are more beneficial for the younger-old (aged 65-84) than the oldest-old (aged 85 and over).

***Key Words*:** Aging-Disability-Resilience-China

Psychological Resilience and the Onset of Activity of Daily Living Disability among Older Adults in China: A Nationwide Longitudinal Analysis

Protective effects of positive psychological assets (e.g. locus of control, self-confidence, mastery) on disability trajectories among older adults have been frequently reported based on studies conducted in western societies (e.g. Clarke & Smith, 2011; Cooper, Huisman, Kuh, & Deeg, 2011; Kempen, Ranchor, van Sonderen, van Jaarsveld, & Sanderman, 2006; Wahl, Schmitt, Danner, & Coppin, 2010). Whether this relationship also applies to less developed countries is not well-known. Sixty percent (279 million) of the world's older population (people age 65 or older) currently live in less developed countries and this proportion is projected to increase to 71 percent (690 million) by 2030 (Kinsella & Phillips, 2005). They are on average considerably less resourceful than their counterparts in developed countries. For example, the main form of their elderly care is via informal support provided by family members (spouse, and especially adult children) who themselves on a daily basis are often struggling to meet a variety of competing demands begotten in the process of rapid socio-demographic and economic changes ensuing the globalization (Kaneda, 2006). The sheer size and growth rate of older population in the developing world makes it a legitimate concern in terms of helping prevent debilitating conditions in later life to promote healthy aging. To better design interventions and help disseminate health-promoting messages, evidence is needed on determinants of older adults' disease and disability in non-western settings.

Among developing countries, China is one of the most rapidly aging. There were more than 109 million people aged 65 or older in 2010 and this number is forecasted to be more than 228 in 2030 and 333 million in 2050 (United Nations, 2010). With 44 million people 59 years old or older with disabilities (OSCNSSD & IP, 2007: 24, cited in Fisher, Shang, & Li,

2011), China is facing a double challenge in both aging and disability. While research has emerged in recent years to evaluate determinants of health and well-being for older adults in China (e.g., Beydoun & Popkin, 2005; Shen & Zeng, 2010; Zhang, Gu, & Hayward (2008); Zeng & Shen, 2010), prospective effects of positive psychological assets on disability in later life has not been adequately examined.

Psychological resilience (referred to as 'resilience' hereafter) is one type of positive psychological assets which constitutes an important component of successful psychosocial adjustment (Lavretsky & Irwin, 2007) found to be linked to health and well-being among older adults (Hardy, Concato, & Gill, 2004). The operational definition of resilience often varies with the specific situations to which it is applied in the literature (e.g., Masten, 2001; Herrman, Stewart, Diaz-Granados, Berger, Jackson, &Yuen, 2011; Wagnild &Young, 1993). It is widely agreed, though, that most measurements use similar conceptual domains to capture resilience. Research shows that these domains, represented by a number of psychological constructs, such as sense of coherence, locus of control, self-esteem, self-confidence, self-efficacy, and optimism, are either sources of, or are correlated to, resilience (Herrman et al., 2011; Judge, Erez, Bono, & Thoresen, 2002; Nygren, Aléx, Jonsén, Gustafson, Norberg, & Lundman, 2005; Resnick, Galik, Dorsey, Scheve, & Gutkin, 2011).

Specifically with regard to functional disability, research has demonstrated that a sense of mastery prospectively predicts lower risks of functional deterioration (Cooper et al. 2011; Fauth, Zarit, Malmberg, & Johansson, 2007; Kempen et al., 2006) and that a higher sense of personal control is associated with reduced risks of disability among older Americans (Clarke & Smith, 2011). Meanwhile, evidence shows that a decline in functional ability is linked to subsequent increases in neuroticism and levels of external control (Wahl et al., 2010) and that

increased disability or functional limitations are associated with higher levels of loneliness (Warner & Kelley-Moore, 2012) and a sense of uselessness (Gruenewald, Karlamangla, Greendale, Singer, & Seeman, 2007). Findings from these studies generally point to the importance of different dimensions of resilience to functional ability.

These studies, however, were limited in several ways: (1) most of them included resilience in the analyses as a confounder rather than a key independent variable; (2) some of them used small and non-representative samples; (3) some of them were based on cross-sectional data; (4) none dealt with the developing countries; (5) these studies also differed widely in the way of defining and measuring disability and choosing covariates, thus making between-study comparison less meaningful.

Furthermore, little research has been done to examine the possible interaction effect of age and resilience on functional disability. Very old age is often described as a period in life dominated by major functional loss, deteriorating comorbidity, and overwhelming frailty (Beckett et al., 1996; Berlau, Corrada, & Kawas, 2009), suggesting that healthy and successful aging has age limits (Baltes & Smith, 2003). Presumably, resilience may play a less salient role in the very old period given the stronger natural forces of morbidity and mortality. In aging research, few studies have examined this age by resilience interaction effect on disability.

In the current study, we attempt to overcome some of the current limitations in the literature by using nationally representative longitudinal data to examine the association between resilience and the onset of ADL disability in China and explore the interaction effect of resilience with age. Drawing on the notion that resilience is a strong protective factor against the onset of ADL disability, we hypothesize that lower levels of baseline resilience would be significantly associated with increased risk in becoming ADL disabled in wave 2, net of a range

of demographic, socioeconomic and psychosocial confounding factors. We also expect that the protective effect of resilience against the onset of ADL disability is stronger for the younger-old elders than the oldest-old considering that psychological influences on health would get weaker when biological forces become overwhelmingly stronger in advanced ages.

METHOD

Data

The data used in this study are from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), an ongoing longitudinal survey launched in 1998 with follow-up surveys implemented in 2000, 2002, 2005, and 2008-2009. The 1998 baseline and the 2000 follow-up waves interviewed people aged 80 and over. Starting from 2002, younger elders aged 65-79 were included in the sample. The deceased were replaced with refresher cohorts in the follow-up waves. CLHLS is representative of the elderly population in China because the respondents are randomly sampled, the sampling frame covers about 85% of the total population of China (Zeng, 2004), and the distributions of key variables are comparable to those reported in other national surveys (Gu & Dupre, 2008).

Analytic Sample

We use data from the third and fourth waves of the CLHLS (2002 and 2005, the fifth wave of 2008-2009 is not available for public use when this project starts) because we are interested in comparing the resilience effect on ADL disability between the younger-old group (recruited in 2002) and the oldest old. Including younger elders also helps reduce survival selection bias compared to a sample exclusively comprised of the oldest old.

The third wave of the CLHLS contains 16,020 respondents who were interviewed in 2002. Among them, 2,012 (12.56%) were lost to follow-up in 2005 while 5,872 (36.65%) died

before being interviewed in the fourth wave in 2005. To further reduce sample selection bias and control for competing risks, we include all the respondents who were 65 years old or older and free of ADL disability at the baseline regardless of their survival or attrition status during the 2002 to 2005 follow-up period (see Fig.1 for the analytical flowchart).

After excluding 4,908 respondents (30.64%) who were already ADL disabled at the baseline in 2002, 11,112 eligible respondents (69.36%) are included in the current study, consisting of 6,791 (61.11%) both-wave interviewees, 2,988 (26.89%) deaths, and 1,333 (12.00%) loss to follow-up.

(Fig. 1 about here)

Measures

ADL disability is defined as having difficulty in doing any of the following six basic tasks: bathing, dressing, toileting, indoor transferring, continence, and feeding. Free of ADL disability means that the respondent was capable of independently performing all of the six activities ("without assistance"). A respondent is considered to have the "onset" of ADL disability if s/he reports having ADL disability in 2005 but was free of ADL disability at the baseline.

The key independent variable of our research interest is resilience. Following previous operationalization (Shen & Zeng, 2010; Zeng & Shen, 2010), resilience is measured by a scale based on five items that clearly represent important dimensions of resilience discussed in many psychological studies (e.g., Campbell-Sills & Stein, 2007; Connor & Davidson, 2003). Table 1 presents the five specific items. The responses to these questions range from 1 (always) to 5 (never). Item 2 and 5 are reversely recoded to make response 1 represents the most negative feeling and 5 the most positive for all of the five questions. Item values are then added up to

create a summary scale ranging from 6 to 25 (mean 19.017), with higher scores indicating higher levels of resilience. The scale of resilience has good reliability with a Cronbach's alpha coefficient equal to 0.89. A principle component analysis is performed, which generated one factor with an eigenvalue of 3.52, explaining 70% of the total variance (see also Table 1).

(Table 1 about here)

A number of confounding variables associated with the onset of ADL disability that have been identified in the literature (e.g., Beydoun & Popkin, 2005) are organized into three categories and controlled for in the analyses. The first set of controls concerns socio-demographic characteristics including age, gender (female versus male), ethnicity (Han versus non-Han), and socioeconomic status (SES). Age is continuously measured in years and is also dichotomized into the oldest old (85 and older) and the younger old (65-84) groups. SES is measured by four variables including education (years of formal schooling), residence (rural versus urban), pension status (receiving versus not receiving), and financial sources based on responses to the question whether the subject had enough financial sources to pay daily expenses (enough versus not enough). The second set of controls taps into family support with two variables including marital status (currently married versus others) and co-residence (currently living with family members versus living alone or in an institution).

The third set of controls concerns respondents' baseline heath status, captured by self-rated health, self-reported presence of chronic conditions, and cognitive limitations. Self-rated health is measured by a single item, asking respondents to rate their health on a 5-point scale (very bad, bad, so-so, good, and very good). It is then dichotomized into "bad/fair" (very bad, bad, and so-so) versus "good" (good and very good). According to the World Bank (2007),

chronic diseases are China's number one health threat, accounting for over 80 percent of its 10.3 million annual deaths. Presence of chronic conditions is marked by having one or more of five main non-communicable diseases including hypertension, diabetes, heart disease, stroke-related conditions, and respiratory-related diseases. Cognitive impairment is measured using the well-validated Chinese version of the Mini-Mental State Examination (MMSE) (see Zhang, Gu, & Hayward, 2008). The scores on Chinese MMSE range from 0 to 30, with higher scores indicating better cognitive function. Mental impairment is indicated by scores lower than 24 (Zeng, Gu, & Land, 2007).

Analytical Strategy

Missing data for most variables of interest is modest except for the MMSE items. Imputation methods are taken to avoid considerable loss of sample size and possible consequent sampling bias. Simple imputation procedures, such as using sample mode and mean to substitute for the missing values, are used in the first place for variables with missing values less than 0.50% (including the outcome variable, which had less than 0.004% missing values in total for some ADL items of both waves respectively).

For variables with missing values more than 0.50%, multiple imputations (MI) are conducted using Stata's ICE (imputation by chained equations) command. One hundred copies of MI datasets (Graham, Olchowski, & Gilreath, 2007) are created and multinomial logistic regression models are fit in each of the 100 MI datasets separately. Then the estimates from the imputed datasets are pooled, using Rubin Rules, to generate a single set of estimates, by using a suite of Stata's mi commands (Statistical Computing Seminars: Multiple Imputation in Stata, Part 1). All analyses are conducted in Stata 11.

Differences between various ADL trajectories groups in wave 2 are compared using $\chi 2$

statistics for categorical variables and ANOVA for continuous variables, as appropriate. In the multinomial logistic regression models, we first test the effects of resilience and socio-demographic characteristics on the ADL status in wave 2 in Model 1. Then we add family support variables to form Model 2. Finally, baseline health status variables are included in Model 3. Product term of resilience with age groups is evaluated in Model 4 (see Table 3). Since this product term (with a cut-point of 85 years old) is statistically significant, we run stratified models for younger-old and oldest-old separately (see Table 4).

Sensitivity tests are conducted to check the consistence and quality of the MI datasets (results available upon request), showing that the analysis models are neither sensitive to the number of imputations nor to which imputation methods are used (Statistical Computing Seminars: Multiple Imputation in Stata, Part 2).

RESULTS

Table 2 presents sample characteristics at the baseline stratified by respondents' disability trajectories and attrition status over the three-year follow-up period. The mean age of the total sample is 83 years. Slightly more than half of the sample are female (52.32%). The majority of the sample are Han Chinese (93.51%), currently not married (63.45%), without retirement pension (77.95%), residing in rural areas (56.04%), living with families (80.26%), and reporting that the financial supports they received from different channels together are sufficient to pay for their daily expenses (80.74%).

By ADL status in wave 2, 51 percent of the sample remained free of ADL disability while more than 9 percent had an incidence of ADL disability. The mean baseline resilience score for those who were free of ADL disability at the baseline but had the onset of ADL disability in wave 2 (18.7) was lower than that of those who remained disability-free (19.3)

($p<0.001$) in wave 2. Those who had the onset of ADL disability were significantly older (88.4 vs.78.6), less educated (1.9 vs. 2.5), less healthy (self-rated bad health 47.1% vs. 44.9; had selected chronic disease 34.9% vs. 31.7%; MMSE impaired: 31.8% vs. 13.9%), and were less likely to be married (25.3% vs. 46.5%) compared with those who remained free of ADL disability.

(Table 2 about here)

Table 3 shows the results from multinomial logistic regression analyses on ADL disability trajectories with free of ADL disability at both waves as the reference category and having the onset of ADL disability at wave 2 as the key comparison group. Two additional outcome categories, namely death and lost-to-follow-up, are also included to minimize sample reduction due to longitudinal attrition. Resilience is a significant and protective factor throughout the three models. One unit increase in the resilience scale at the baseline corresponds to a 4.2% (1/0.96=1.04) reduction in the odds of developing ADL disability during the follow-up time, net of socio-demographic characteristics at the baseline (Model 1). This association hardly changes with family support factors being added to the model (Model 2) and slightly decreases with additional controls of baseline health conditions included (Model 3). Although risks of deaths and lost-to-follow-up are not the focus of our attention, a quick note is worthwhile to indicate that resilience effect on mortality is similar to that on disability across the models.

The last model (Model 4) adds an interaction term between resilience and age group dichotomized into younger elders aged 65 to 84 and the oldest old aged 85 or older. This term turns out to be significant and positive, indicating that the beneficial effect of resilience is weaker for the oldest old group relative to the younger elderly group.

(Table 3 about here)

We then fit Model 4 separately for the two age groups (Table 4). The protective effect of resilience is only manifested in the younger-old group (Model 5), where one unit increase in the baseline resilience scale is associated with a 7% reduction in the risk of ADL disability incidence during the 3-year follow-up period. This association is not significant for the oldest-old group (Model 6).

(Table 4 about here)

The results on the control variables are largely consistent across the models and samples. Protective factors include younger age, male gender, non-Han ethnicity, rural residence, being currently married, and having no chronic diseases or cognitive impairment. Surprisingly, no significant effect is found for education or financial resources, and receiving a pension exhibits detrimental effects.

DISCUSSION

Analyzing 2002 and 2005 waves of data from a large-scale, nationwide longitudinal survey of older adults in China, we find psychological resilience at the baseline is prospectively linked to the onset of ADL disability during the three-year follow-up among ADL disability-free adults aged 65 or older, after controlling for a range of socio-demographic, family support, and health status confounders at the baseline. Our results also reveal that this benefit is stronger for younger elders than for the oldest old. To our knowledge, this is the first prospective cohort study based on a nationally representative sample to explore these issues in a developing country setting, especially China.

The resilience effect appears robust independent of a host of strong controls given a relatively short follow-up time (3 years). This finding is supportive of our main hypothesis and

also consistent with studies that have reported beneficial effects of positive psychological characteristics on functional status in the developed countries (e.g., Clarke & Smith, 2011; Cooper et al. 2011; Gruenewald et al., 2007; Kempen et al., 2006;Warner & Kelley-Moore, 2012) and on mortality and longevity in China (Shen & Zeng, 2010; Zeng & Shen, 2010).

Using the same two waves of CLHLS data and a similar resilience scale (our current scale overlaps with most of its items), Shen & Zeng (2010) found that the total resilience score and most items of the resilience scale are significantly associated with reduced mortality risk among the older adults, with young-old benefitting more than the oldest-old. Zeng & Shen (2010) further discovered, using the newest 2008-2009 wave of CLHLS, that resilience significantly contributes to longevity at all age; even a nonagenarian aged 94–98 with better resilience has a higher likelihood of becoming a centenarian compared to nonagenarians with lower resilience. Findings from our present study make additional contribution to the literature on top of these published findings on mortality and longevity by focusing on disability. It's also worth noting that although we focus solely on disability and we include the subjects who were dead to avoid sample attribution, a glimpse of our findings regarding mortality shows that resilience is also protective for mortality, consistent with Shen & Zeng (2010).

The causal pathways through which resilience may help reduce the risk of the onset of ADL disability are presumably complex and multidimensional. A "direct effect" of positive psychological characteristics on subsequent health may operate through a resilient person's abilities in strengthening of neuro-endocrine, immune, and cardiovascular systems (Curtis & Ciccetti, 2003; Ong, Bergeman, & Booker, 2009). Positive psychological characteristics, reflecting the functions of the mind, usually direct the body to engage in positive behaviors and activities that often promote health-enhancing social interactions, healthy lifestyles, and

efficiency of resource utilization, and in turn, reduce or delay the incidence of disability (Cooper et al., 2011). Moreover, in the case of the disablement process, when faced with declining physical capacity, a more resilient elder may draw on a variety of different strategies (e.g., change the way he/she does an activity) to maintain his/her activity independence (Clarke & Smith, 2011). By coping with more active, problem-focused strategies, resilient individuals reduce exposure to stress hormones and therefore protect the brain (Vahia, Chattillion, Kavirajan, & Depp, 2011) which may in turn help maintain functional ability. All these mechanisms may contribute to disability prevention or slow down the disablement process.

Another important finding of this study is that the resilience effect is stronger for the younger-old group (aged 65 to 84) but not for the oldest old (85 and up), consistent with our hypothesis. In the literature of aging studies, older adults are often divided into subgroups of "young-old" and "oldest-old" defined using various cut-points such as 80, or 85 years of age (e.g., Fauth et al., 2007; Nygren et al., 2005; Shen & Zeng, 2010). We test both cut-points and find that only the age group distinguished by age 85 exhibits significant interaction effects with resilience ($p = 0.01$).

One possible explanation is that psychological influences are inherently limited in the most advanced age when biological or genetic morbidity and mortality forces are taking an overwhelming control. Indeed, individuals aged 85 years or older have the highest levels of physical and cognitive disability compared with adults of other ages (Beckett et al., 1996; Kunkel & Appelbaum, 1992). This finding suggests that intervention programs aimed for improving resilience and promoting healthy aging should start early in elderhood, as resilience is potentially modifiable and seems to be promoting healthy aging until strong biological forces kick in beyond certain advanced age (e.g., see Seeman & Unger, 1999; Gruenewald et al., 2007).

The results on some control variables also merit some comments. Neither education nor income are significant; and receiving a retirement pension is linked to *higher* likelihood of the onset of ADL disability—a finding contradictory to the routinely reported evidence in the health stratification literature that people with better economic conditions are healthier. It is possible that socioeconomic resources, captured by the measures used in this study, do not adequately reflect health-promoting resources most relevant to health and well-being of Chinese elders. They may be less linked to factors directly related to functional status such as healthful lifestyles or healthcare. More sophisticated multilevel measures of SES are needed to refine the analysis. For example, adult children's SES is likely a salient indicator of material resources the older parent can draw upon in daily life but this aspect of SES is largely omitted in aging research in China and elsewhere. Survival selection bias may also play a role. Older adults supported with a pension have a survival advantage compared to those without a pension who, if surviving into an old age, tend to be particularly strong in terms of mental and physical health. As to the finding that rural residence is protective against ADL disability onset, it is possible that the built environment in rural areas, characterized by design factors such as greater land-use diversity and less air pollution than cities, may serve as a facilitator of physical activity and thus a deterrent to disability in later-life (Clarke & George, 2005).

In addition to SES, we also include marriage and living arrangement as two family-related factors in the analyses. Family coresidence is strongly linked to increased risk of ADL disability incidence. In this sample, the importance of living arrangement clearly outweighs that of marriage. The role of living with family members especially adult children in contributing to health and well-being of older adults needs to be further studied particularly in countries like China where the major responsibilities of elderly care remain a family duty rather than a state

responsibility. This situation may soon change, however, given the one-child policy strictly implemented in most China provinces for the last thirty years.

One last note is that we test the effect of resilience on recovery as well (results not shown) and find out similar protective impacts of resilience as it does on the onset of ADL disability yet this is beyond the scope of the current study.

Findings from this study should be interpreted with caution due to limitations. First, although this study makes use of a prospective cohort design, it remains an observational study and causation should not be assumed in the observed associations. We control for a range of socio-demographic, family support, and health confounders, but the issue of omitted variables cannot be completely avoided. Second, we include participants who were free of ADL disability at the baseline, excluding those with pre-existing disability conditions; this inclusion criteria may have led to a positively selected sample of elders healthier than the general aging population. Third, the follow-up period is only three years and that may not be long enough for the resilience effect to fully manifest. The main and interaction effect of resilience may be different if the follow-up period is longer.

That said, this study also has several noteworthy strengths: it benefits from a prospective cohort design, uses a nationally representative sample, investigates under-researched questions about the impact of resilience on ADL disability incidence a developing country, and controls for competing risks in the analyses. The findings can be used to identify elders at greater risks of developing severe disability and make contributions to evidence-based interventions to enhance Chinese elders' psychological resilience level, delaying functional decline and the onset of disability, prolonging the period of healthy aging, and in turn, promoting longevity with compression of morbidity and disability. The current study is exclusively focused on the

incidence of ADL disability over a 3-year follow-up period. Future studies should investigate the resilience effect across longer follow-up period of time addressing additional health outcomes such as incidence and progression of chronic conditions. As China's population age structure becomes less pyramid- and more beanpole-shaped, research on factors protective against morbidity, disability, and mortality for older adults should be substantially expanded, collecting more longitudinal data based on representative samples, and providing evidence useful to strengthen the effectiveness of disease and disability prevention for Chinese elders.

Word count: 4,429

ACKNOWLEDGEMENTS

We thank Michael F. Timberlake for helpful comments on the original draft.

REFERENCES

Baltes, P. B., & Smith, J. (2003). New frontiers in the future of aging: From successful aging of the young old to the dilemmas of the fourth age. *Gerontology,* 49:123–135. doi: 10.1159/000067946

Beckett, L. A., Brock, D. B., Lemke, J. H., Mendes De Leon, C. F., Guralnik, J. M., Fillenbaum, G. G., … Evans, D. A. (1996). Analysis of change in self-reported physical function among older persons in four population studies. *American Journal of Epidemiology,* 143: 766–778. doi:10.1093/oxfordjournals.aje.a008814

Berlau, D., J., Corrada, M. M., & Kawas, C. (2009). The prevalence of disability in the oldest-old is high and continues to increase with age: Findings from the 90+ Study. *International Journal of Geriatric Psychiatry,* 24(11): 1217-1225. doi:10.1002/gps.2248

Beydoun, M. A., & Popkin, B. M. (2005). The impact of socio-economic factors on functional status decline among community-dwelling older adults in China. *Social Science & Medicine,* 60(9): 2045-2057. doi:10.1016/j.socscimed.2004.08.063

Campbell-Sills, L., & Stein, M. B. (2007). Psychometric analysis and refinement of the Connor-Davidson resilience scale (CD-RISC): Validation of a 10-item measure of resilience. *Journal of Traumatic Stress,* 20(6): 1019-1028. doi:10.1002/jts.20271

Clarke, P. & George, L. K. (2005). The role of the built environment in the disablement process. *American Journal of Public Health,* 95(11): 1933-1939. doi:10.2105/AJPH.2004.054494

Clarke, P., & Smith, J. (2011). Aging in a cultural context: Cross-national differences in

disability and the moderating role of personal control among older adults in the United States and England. *The Journals of Gerontology Series B: Psychological Sciences & Social Sciences,* 66(4), 457-467. doi:10.1093/geronb/gbr054

Connor, K. M., & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson resilience scale (CD-RISC). *Depress Anxiety,* 18(2): 76-82. doi:10.1002/da.10113

Cooper, R., Huisman, M., Kuh, D., & Deeg, D. J. H. (2011). Do positive psychological characteristics modify the associations of physical performance with functional decline and institutionalization? Findings from the longitudinal aging study Amsterdam. *Journals of Gerontology Series B: Psychological Sciences & Social Sciences,* 66B (4), 468-477. doi: 10.1093/geronb/gbr049

Curtis, W. J., & Cicchetti, D. (2003). Moving research on resilience into the 21st century: Theoretical and methodological considerations in examining the biological contributors to resilience. *Development and Psychopathology,* 15: 773–810. doi: 10.1017/S0954579403000373

Fauth, E., Zarit, S. H., Malmberg, B., & Johansson, B. (2007). Physical, cognitive, and psychosocial variables from the disablement process model predict patterns of independence and the transition into disability for the oldest-old. *Gerontologist,* 47(5): 613-624. doi:10.1093/geront/47.5.613

Fisher, K. R., Shang, X. & Li, Z. (2011). Absent role of the state: Analysis of social support to older people with disabilities in rural China. *Social Policy & Administration,* 45(6): 633–648. doi: 10.1111/j.1467-9515.2011.00799.x

Graham, J. W., Olchowski, A. E., & Gilreath, T. D. (2007). How many imputations are really

needed? Some practical clarifications of multiple imputation theory. *Prevention Science: The Official Journal of the Society for Prevention Research,* 8(3): 206-13. doi: 10.1007/s11121-007-0070-9

Gruenewald, T. L., Karlamangla, A. S., Greendale, G. A., Singer, B. H. & Seeman, T. E. (2007). Feelings of usefulness to others, disability, and mortality in older adults: The MacArthur study of successful aging. *Journal of Gerontology: Psychological Sciences,* 62B(1): 28-37. doi:10.1093/geronb/62.1.P28

Gu, D., & Dupre, M. E. (2008). Assessment of reliability of mortality and morbidity data in the 1998, 2000, and 2002 CLHLS waves. In Y. Zeng, D. Poston, J. Smith, & D. A. Vlosky (Eds.), *Healthy longevity in China: Demographic, socioeconomic, and psychological dimensions* (pp. 99-115). New York: Springer.

Hardy, S. E., Concato, J., & Gill, T. M. (2004). Resilience of community dwelling older persons. *Journal of the American Geriatrics Society,* 52: 257–262. doi:10.1111/j.1532-5415.2004.52065.x

Herrman, H., Stewart, D. E., Diaz-Granados, N., Berger, E. L., Jackson, B., & Yuen, T. (2011). What is resilience? *Canadian Journal of Psychiatry, 56*(5): 258-265. PMid:21586191

Judge, T. A., Erez, A., Bono, J. E., & Thoresen, C. J. (2002). Are measures of self-esteem, neuroticism, locus of control, and generalized self-efficacy indicators of a common core construct? *Journal of Personality & Social Psychology,* 83(3): 693-710. doi:10.1037/0022-3514.83.3.693

Kaneda, T. (2006). Health care challenges for developing countries with aging populations. *Population Reference Bureau*.

Kempen, G. I. J. M., Ranchor, A. V., van Sonderen, E., van Jaarsveld, C. H. M., & Sanderman,

R. (2006). Risk and protective factors of different functional trajectories in older persons: Are these the same? *The Journals of Gerontology: Psychological Sciences and Social Sciences* 61: 95–101.doi: 10.1093/geronb/61.2.P95

Kinsella, K., & Phillips, D. R. (2005). Global aging: The challenge of success. *Population Bulletin 60, No. 1*. Washington, DC: Population Reference Bureau. Retrieved Nov. 5, 2012 from http://www.prb.org/Articles/2006/HealthCareChallengesforDevelopingCountrieswithAgingPopulations.aspx

Kunkel, S. R. & Appelbaum, R. A. (1992). Estimating the prevalence of longterm disability for an aging society. *Journal of Gerontology: Social Sciences,* 47:S253–S260.

Lavretsky, H. & Irwin, M. R. (2007). Resilience and Aging. *Aging Health,* 3(3): 309-323. doi:10.2217/1745509X.3.3.309

Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist,* 56(3): 227-238. doi:10.1037/0003-066X.56.3.227

Nygren, B., Aléx, L., Jonsén, E., Gustafson, Y., Norberg, A., & Lundman, B. (2005). Resilience, sense of coherence, purpose in life and self-transcendence in relation to perceived physical and mental health among the oldest old. *Aging & Mental Health* 9(4), 354-362. doi:10.1080/1360500114415

Ong, A. D., Bergeman, C. S., & Boker, S. M. (2009). Resilience Comes of age: Defining features in later adulthood. *Journal of Personality,* 77(6): 1777-1804. doi:10.1111/j.1467-6494.2009.00600.x

Resnick, B., Galik, E., Dorsey, S., Scheve, A., & Gutkin, S. (2011). Reliability and validity testing of the physical resilience measure. *The Gerontologist,* 51(5): 643–652.

doi:10.1093/geront/gnr016

Shen, K. & Zeng, Y. (2010). The association between resilience and survival among Chinese elderly. *Demographic Research,* 23: 105-116. doi:10.4054/DemRes.2010.23.5

Statistical Computing Seminars: Multiple Imputation in Stata, Part 1. *UCLA: Academic Technology Services, Statistical Consulting Group.* Retrieved October 24, 2011 from http://www.ats.ucla.edu/stat/stata/seminars/missing_data/mi_in_stata_pt1.htm.

Statistical Computing Seminars: Multiple Imputation in Stata, Part 2. *UCLA: Academic Technology Services, Statistical Consulting Group.* Retrieved October 24, 2011 from http://www.ats.ucla.edu/stat/stata/seminars/missing_data/mi_in_stata_pt2.htm.

Seeman, T. E., & Unger, J. B. (1999). Self-efficacy beliefs and perceived declines in functional ability: MacArthur studies of. [Article]. *Journals of Gerontology Series B: Psychological Sciences & Social Sciences, 54B*(4), P214. doi:10.1093/geronb/54B.4.P214

United Nations. (2010). World population prospects, the 2010 revision. Retrieved November 5, 2012 from http://esa.un.org/unpd/wpp/P-WPP/htm/PWPP_Population-Age_65Plus.htm.

Vahia, I. V., Chattillion, E., Kavirajan, H., & Depp, C. A. (2011). Psychological protective factors across the lifespan: implications for psychiatry. *Psychiatric Clinics of North America, 34*: 231-248. doi: 10.1016/j.psc.2010.11.011

Wagnild, G. M., & Young, H. M. (1993). Development and psychometric evaluation of the resilience scale. *Journal of Nursing Measurement*, 1:165–178. PMid:7850498

Wahl, H-W., Schmitt, M., Danner, D., & Coppin, A. (2010). Is the emergence of functional ability decline in early old age related to change in speed of cognitive processing and also to change in personality? *Journal of Aging & Health* 22(6): 691-712. doi:10.1177/0898264310372410

Warner, D. F., & Kelley-Moore, J. (2012). The social context of disablement among older adults: Does marital quality matter for loneliness? *Journal of Health & Social Behavior,* 53(1): 50-66. doi:10.1177/0022146512439540

World Bank. (2007). *Toward a healthy and harmonious life in China: Stemming the rising tide of non-communicable Diseases.* Retrieved from http://www.worldbank.org/content/dam/Worldbank/document/NCD_report_en.pdf.

Zeng, Y. (2004). Chinese longitudinal healthy longevity survey and some research findings. *Geriatrics & Gerontology International,* 4: S49-S52. doi:10.1111/j.1447-0594.2004.00147.x

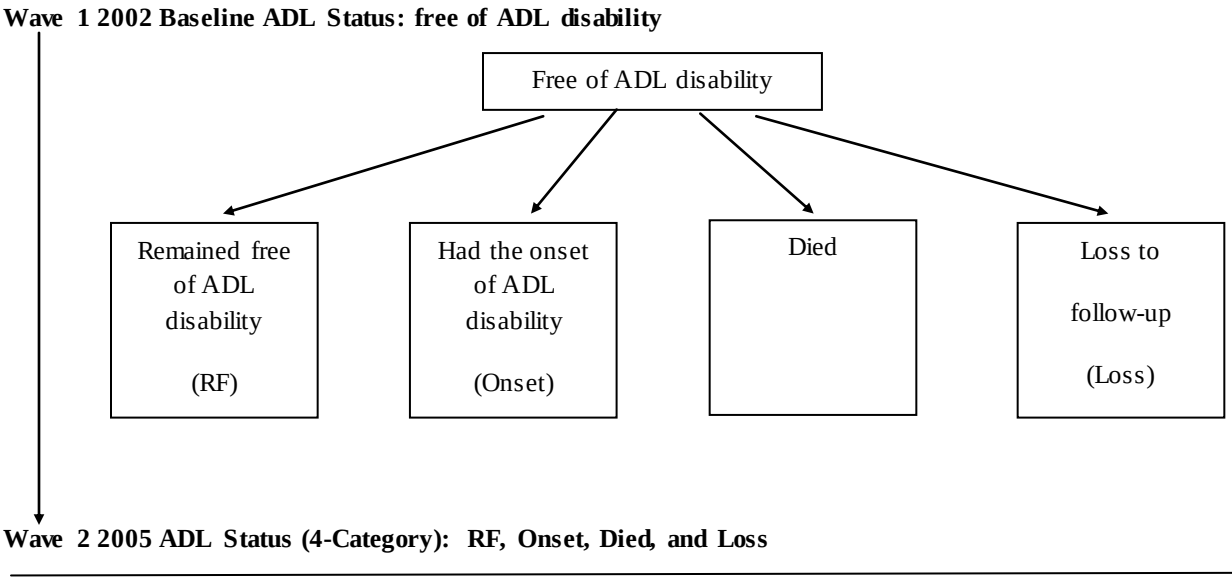
Zeng, Y, Gu, D., & Land, K. C. (2007). The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. *Demography,* 44(3): 497-518. doi: 10.1353/dem.2007.0033

Zeng, Y., & Shen, K. (2010). Resilience significantly contributes to exceptional longevity. *Current Gerontology and Geriatrics Research,* Vol (2010): 525693. doi:10.1155/2010/525693

Zhang, Z., Gu, D., & Hayward, M. D. (2008). Early life influences on cognitive impairment among oldest old Chinese. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 63(1):S25-S33. doi:10.1093/geronb/63.1.S25

FIGURES

Figure 1 Analytical Flowchart for ADL Transitions between 2002 and 2005



TABLES

Table 1 Resilience Scale, CLHLS 2002 (N=16,020)

Items	Alpha[a]	Eigenvalue	Factor loading
1 Do you feel the older you get, the more useless you are?	0.866	3.522	0.831
2 Do you always look on the bright side of things?	0.858	0.621	0.839
3 Do you often feel fearful or anxious?	0.861	0.365	0.865
4 Do you often feel lonely and isolated?	0.861	0.270	0.858
5 Can you make your own decisions concerning your personal affairs?	0.875	0.223	0.803

[a] Alpha coefficient of the resilience scale is equal to 0.888.

Table 2 Sample Characteristics at Baseline, Total and by ADL Status at Wave 2[a], CLHLS 2002 (N=11,112)

Variables	Total Sample (100%)	RF (51.44%)	Onset (9.67%)	Died (26.89%)	Loss (12.00%)
Resilience scale (mean±SD, range)[b]	19.017	19.315***	18.719***	18.493***	19.153***
	±3.049	±3.005	±3.127	±2.988	±3.129
	6-25	6-25	7-25	6-25	8-25
Age in years	82.974	78.590***	88.375***	90.286***	81.031***
(mean±SD, range)	±11.117	±9.641	±9.499	±9.732	±10.829
	65-120	65-116	65-111	65-120	65-113
Female (vs. male; %)	52.32	50.33	60.93	52.84	52.74
Years of schooling	2.253	2.477***	1.894***	1.641***	2.958***
(mean±SD, range)	±3.585	±3.668	±3.409	±3.053	±4.188
	0-25	0-25	0-25	0-22	0-20
Rural residence (vs. urban; %)	56.04	58.54	52.84	60.91	36.98
Han (vs. non-Han; %)	93.51	92.74	94.98	92.57	97.75
Had enough financial sources (vs. lack of; %)	80.74	80.67	81.02	78.75	85.30
Had pension (vs. no; %)	22.05	22.85	21.95	13.52	37.81
Currently married (vs. other marital status; %)	36.55	46.54***	25.30***	20.01***	39.83***
Living with family (vs. living alone/in an institution; %)	80.26	82.23***	81.95***	78.41***	74.64***
Self-rated bad health (vs. good health; %)[c]	47.59	44.85***	47.05***	52.42***	48.95***
Had selected chronic disease(s) (%)[d]	32.56	31.73***	34.93***	31.39***	36.81***
MMSE impaired (vs. unimpaired; %)[e]	22.68	13.91***	31.75***	38.51***	17.57***

[a] ADL Status at wave 2 is a 4-category variable: remained free of ADL disability (RF), had the onset of ADL disability (Onset), Died, and loss to follow up (Loss). Reference group of each covariate is listed in the parentheses.

[b c d e] Sample statistics reported for these variables are generated from summarizing all imputed datasets (m=100), thus sample sizes vary across these variables.

***p<.001.

Table 3 Odds Ratios of Multinomial Logistic Regression Models for ADL Status at Wave 2[a], CLHLS 2002-2005 (N=11,112)

	Model 1			Model 2			Model 3			Model 4[b]		
	Onset	Died	Loss	Onset	Died	Loss	Onset	Died	Loss	Onset	Died	Loss
Resilience scale	.960**	.949***	.950***	.961**	.953***	.953***	.972*	.975**	.962**	.939**	.974*	.949***
Age in years	1.099***	1.118***	1.030***	1.096***	1.113***	1.028***	1.095***	1.110***	1.027***	1.385	4.273***	.839
Female (vs. male)	1.329***	.748***	1.222**	1.293**	.706***	1.197*	1.264**	.677***	1.179*	1.229*	.675***	1.165*
Years of schooling	.997	.988	1.006	.997	.989	1.006	.997	.991	1.007	.989	.980*	1.004
Rural residence (vs. urban)	.842*	.972	.512***	.837*	.975	.521***	.841*	.963	.518***	.809**	.922	.511***
Han (vs. non-Han)	1.760***	1.262*	3.090***	1.822***	1.294*	2.997***	1.769***	1.253*	2.965***	1.739***	1.232*	2.990***
Had enough financial sources (vs. lack of)	1.021	.976	1.232*	1.000	.969	1.275**	1.044	1.051	1.324**	1.052	1.046	1.325**
Had pension (vs. no)	1.596***	.905	1.804***	1.616***	.935	1.838***	1.535***	.894	1.804***	1.545***	.898	1.837***
Currently married (vs. other marital status)				.862	.731***	.977	.852	.715***	.967	.662***	.533***	.916
Living with family (vs. living alone/in an institution)				1.303**	1.087	.693***	1.329**	1.127	.704***	1.414***	1.218**	.711***
Self-rated bad health (vs. good health)							1.129	1.427***	1.178*	1.079	1.350***	1.173*
Had selected chronic disease(s)							1.419***	1.322***	1.069	1.358***	1.245***	1.073
MMSE impaired (vs. unimpaired)							1.264*	1.476***	1.172	1.598***	1.904***	1.235*
Resilience scale × Age group										1.063*	1.011	1.037

[a] ADL Status at wave 2 is a 4-category variable: remained free of ADL disability (RF), had the onset of ADL disability (Onset), Died, and loss to follow up (Loss). Remained free of ADL disability (RF) is the reference category. Reference group of each covariate is listed in the parentheses.

[b] In Model 4, it is "Age groups" rather than "Age in years".

*p<.05; **p<.01; ***p<.001. The number of imputed datasets is 100 (m=100).

Table 4 Odds Ratios of Multinomial Logistic Regression Full Models for ADL Status at Wave 2[a], Stratified by Age Groups, CLHLS 2002-2005 (N=11,112)

	Model 5			Model 6		
	Younger-old (65-84) (N=6,212)			Oldest-old (85 and up) (N=4,900)		
	Onset (5.97%)	Died (12.99%)	Loss (13.49%)	Onset (14.37%)	Died (44.51%)	Loss (10.10%)
Resilience scale	.934**	.977	.947***	1.001	.983	.989
Female (vs. male)	.978	.640***	1.262**	1.407**	.703***	.981
Years of schooling	.983	.988	1.000	.991	.976	1.011
Rural residence (vs. urban)	.727*	.917	.483***	.880	.954	.563***
Han (vs. non-Han)	1.855*	.989	2.419	1.814**	1.396**	4.137***
Had enough financial sources (vs. lack of)	1.089	1.017	1.351**	1.035	1.058	1.259
Had pension (vs. no)	1.519**	.852	1.840***	1.546**	.930	1.733***
Currently married (vs. other marital status)	.700**	.564***	.949	.600***	.499***	.800
Living with family (vs. living alone/in an institution)	1.372	1.094	.724**	1.438**	1.275**	.702**
Self-rated bad health (vs. good health)	1.187	1.416***	1.172	.995	1.292**	1.164
Had selected chronic disease(s)	1.573***	1.306**	1.070	1.183	1.163	1.071
MMSE impaired (vs. unimpaired)	1.582**	2.082***	.991	1.559***	1.849***	1.413**

[a] ADL Status at wave 2 is a 4-category variable: remained free of ADL disability (RF), had the onset of ADL disability (Onset), Died, and loss to follow up (Loss). Remained free of ADL disability (RF) is the reference category. Reference group of each covariate is listed in the parentheses.
*p<.05; **p<.01; ***p<.001. The number of imputed datasets is 100 (m=100).