# Can Humans Achieve the Goal of Longer Life and Healthy Aging?

## -- Lessons Learned from Chinese Longitudinal Healthy Longevity Study

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We all need to remember George Myers' outstanding contributions in international aging studies,
perhaps especially we Chinese demographers need to do so,

→As early as in 1992, George Myers predicted the rapid increase of old-old and the serious problems of aging in China if proper actions are not taken;

→George Myers helped to train Chinese demographers in population aging studies ;

→I also personally appreciate very much for George Myers' encouragements and help ;

→ Now, I would like to, on behalf of the Chinese research team o healthy longevity, report some of the lessons we have learned, following George Myers sprit and willing for old people's better health and life quality.

# A. The Chinese Longitudinal Healthy Longevity Survey (CLHLS)

**Principal Investigator: Zeng Yi**

**Funding Resources: NIA/NIH, China Natural and Social Sciences Foundations, UNFPA, Hong Kong Research Grants Council.**

**General Goals of the Study :To better understand determinants of healthy longevity, such as social, economical, behavioral, environmental and biological factors.**

**The total sample size in 1998 and 2000 was 8,959 and 11,161 oldest-old aged 80+;The total sample sizes in 2002 and 2005 are about 20,000 interviewees including oldest-old aged 80+ (focus), younger elderly aged 65-79 (as a comparison group) and elders' adult children (intergenerational relations and healthy longevity).**

**The CLHLS surveys were conducted in randomly selected half of the counties and cities of 22 provinces out of 31 provinces in 1998, 2000, 2002,** and 2000, covering 85% of total population.

**We use internationally compatible survey instruments to collect comprehensive data on elderly health and related factors (see our Website for details)**

**Totalling in the four waves, 51,100 face-to-face interviews were conducted with elders, among them:**

**10,879 aged 100+; 13,985 aged 90-99;**
**16,505 aged 80-89; 9,731 aged 65-79**

- **At each wave, the longitudinal survivors were re-interviewed, and the deceased interviewees were replaced by additional participants.**
- ***In the 2000, 2002, 2005 follow-up waves, d*ata on mortality and health status before dying for the 12,136 elders aged 65-112 who died between the waves were collected in interviews with a close family member of the deceased.**
- **We also interviewed (with following-up) 4,478 elderly interviewees' children aged 35-65 in 2002 and 2005.**

# Survey Instruments

## Survey Instruments for the elderly interviewees

- Socioeconomic-demographic Characteristics
- Reported health status
- Functional ability: ADL and IADL
- Physical Performance Test
- Cognitive function
- Social support and family support (time and costs)
- Subjective well-being
- Life Style, diet, exercise, smoking, and alcohol drinking
- Family characteristics including family history of longevity
- Accessing to health care resource
- Objective measurements

# Survey Instruments

**In follow-up surveys, interview one of the close family members of deceased interviewees:**

- ***Collect information before death (35 variables):*** **Socioeconomic & demographic characteristics, date and cause of death, disease, ADL, number of days of bed ridden, medical treatments and costs, life style, caregivers, financial support, and social contact.**

# Data Quality

- Careful evaluations have shown that the data quality of the 1998, 2000, 2002, and 2005 surveys is generally good, as compared to some U.S. and Canadian elderly surveys (Gu, 2004).
- The overall age reporting in CLHLS is acceptably accurate.
- However, we also realize that some problems exist in the data sets. For example, chronic diseases were under-reported, death rates between age 80 to 94 were under-reported by about 7-10%, while death rates reporting at ages 95-110 were rather good.

# CLHLS data availability

**The 1998 baseline, 2000, and 2002 follow-up healthy longevity survey data sets have been (and 2005/2008 data sets will be) distributed internationally:**

**(http://www.pubpol.duke.edu/centers/ppa/)**

**(http://www.pku.edu.cn/academic/ageing/).**

Email contacts: gudanan@duke.edu in U.S.

chafs@pku.edu.cn at PKU in China

# B. Some *findings* from CLHLS project

## *B1. Health Life Expectation Study based on CLHLS data*

### *The unique CLHLS data on ADL before dying led to methodological improvement*

- We found that conventional multi-state life table underestimate disabled life expectancies, due to the unreasonable assumption of no changes in ADL status from age x to death if a person dies in the age interval (x, x+n), because of lack of data on health status before dying; We found the biases are mostly sizable and statistically significant.
- We extended the multi-state life table method and applied it to the CLHLS data including ADL before dying to improve the ADL-status-based estimates of active and disabled life expectancies.

--Zeng, Yi; Gu, Danan, and Land, K. C. 2004. "A New Method for Correcting Underestimation of Disabled Life Expectancy and Application to Chinese Oldest-Old." *Demography*, Vol. 41 (2).

**→Above study based on 1998-2000 CLHLS data focusing on oldest-old aged 80+ only; We have recently extended this study to all elderly aged 65+, using the 2002-2005 CLHLS data.**

Figure 3, % of the Underestimation of Disable Life Expectancies (disregarding ADL status at initial ages, rural and urban combined), Based on conventional Multistate Life-Table Methods

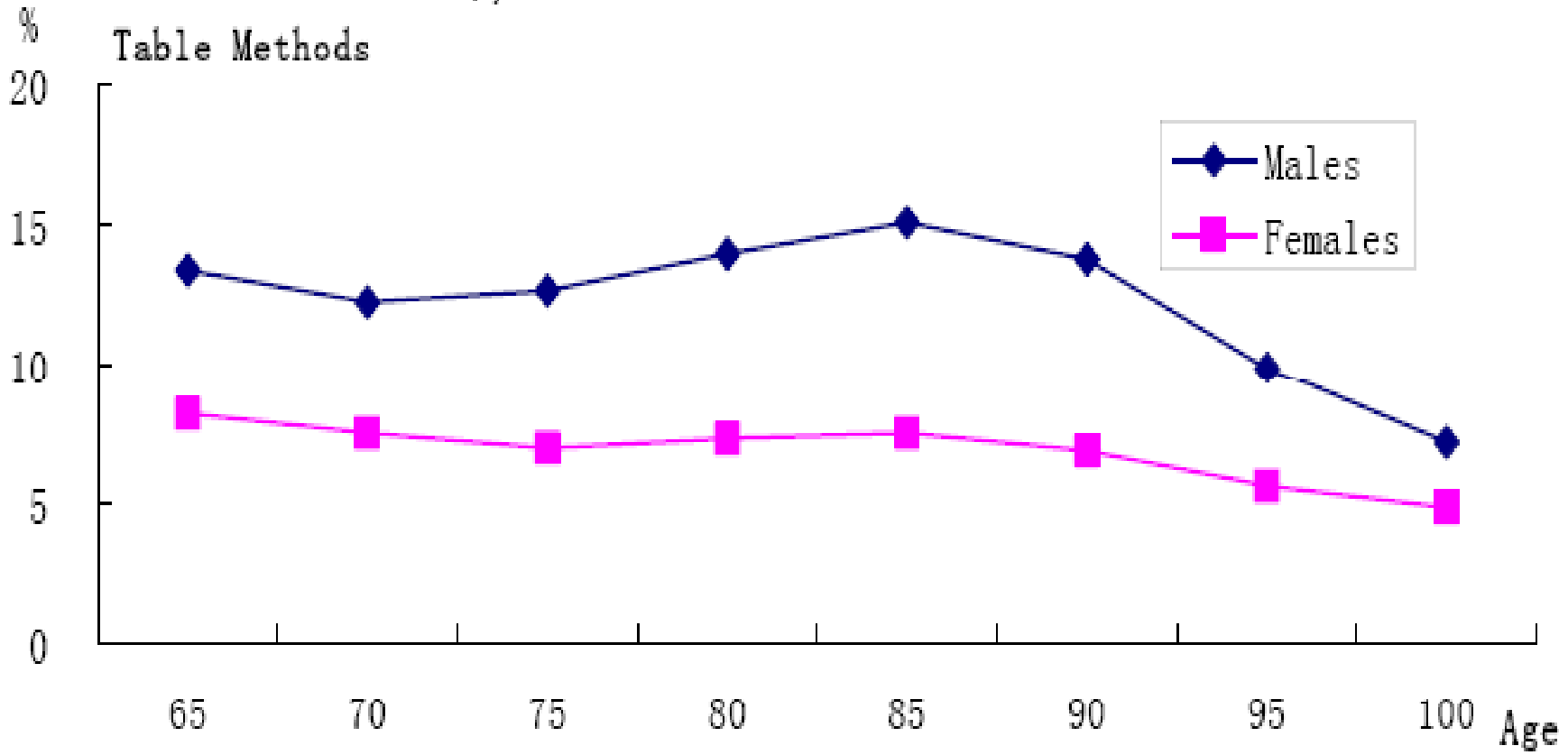


Figure1, Percentage of Remaining Life Spent in Active Status Among Chinese Rural and Urban elderly(two sexes combined) Who are Active or Disable at Initial Age

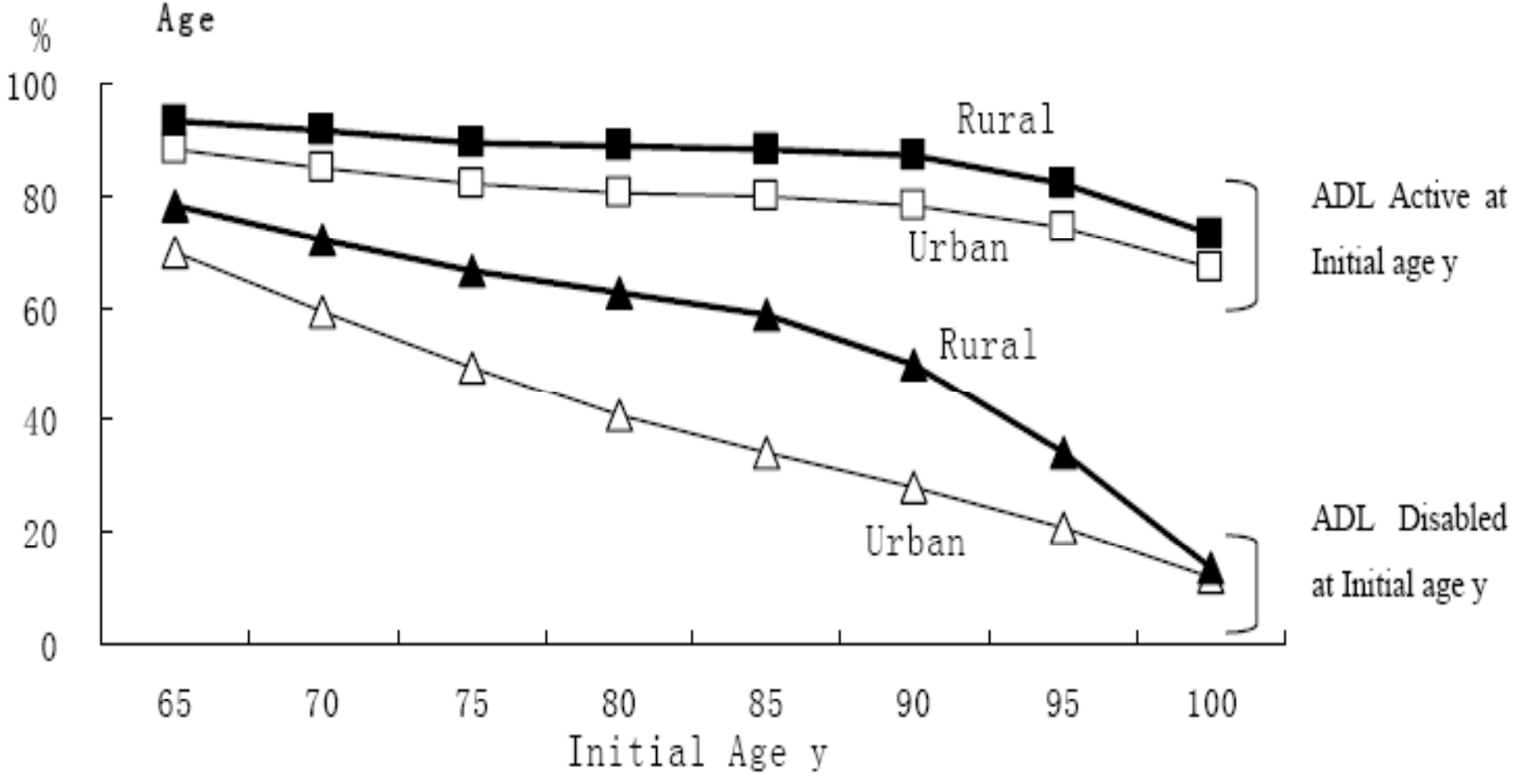


Figure 2, Percentage of Remaining Life Spent in Active Status Among Chinese elderly Men and Women (rural and urban combined) Who are Active or Disable at Initial Age

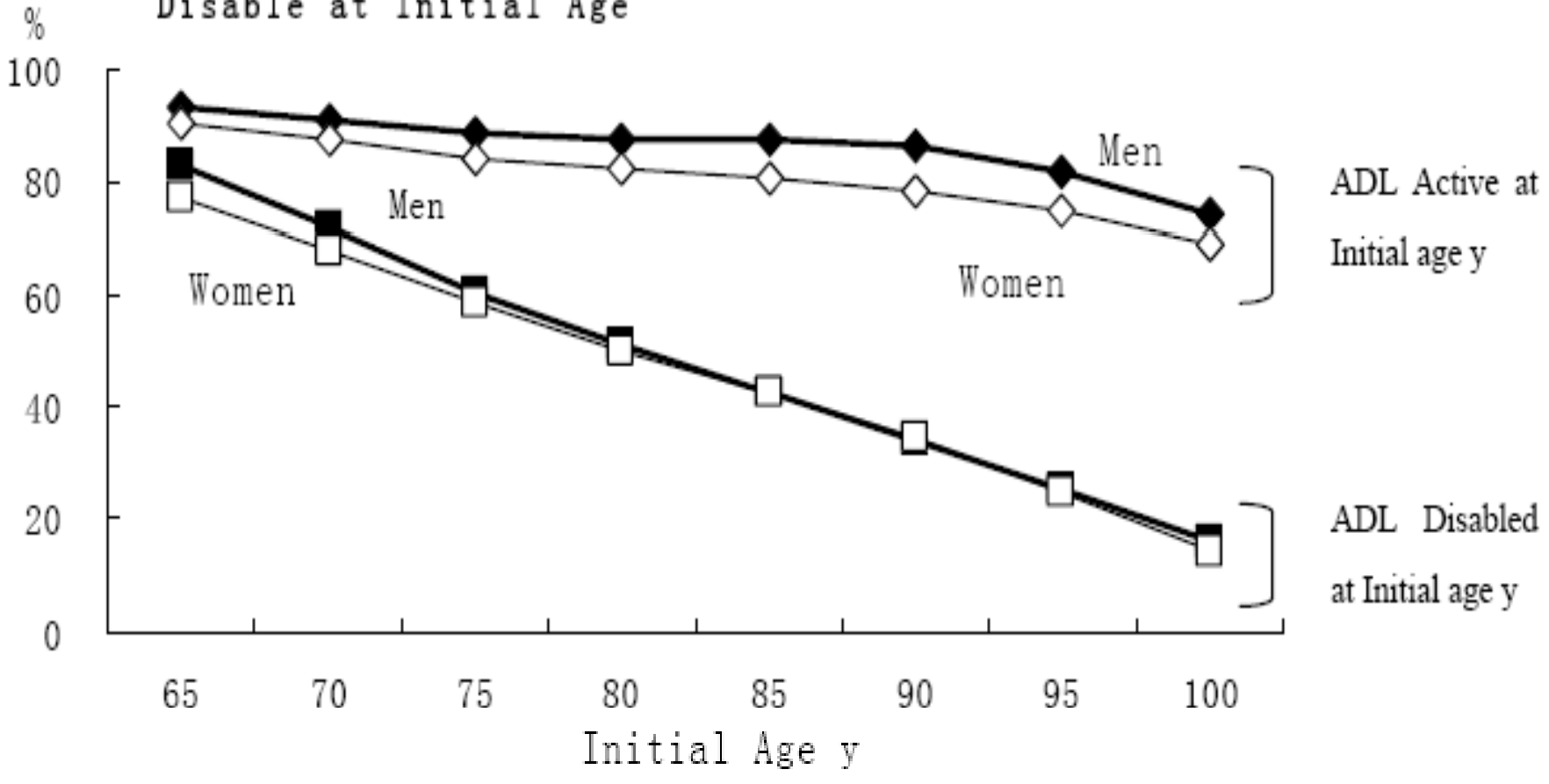


Figure 5. Average Expected Daily-life-Care Cost in the Rest of the Life of Chinese Elderly (Rural and Urban Combined), with Different Scenarios of Reduction of Disability

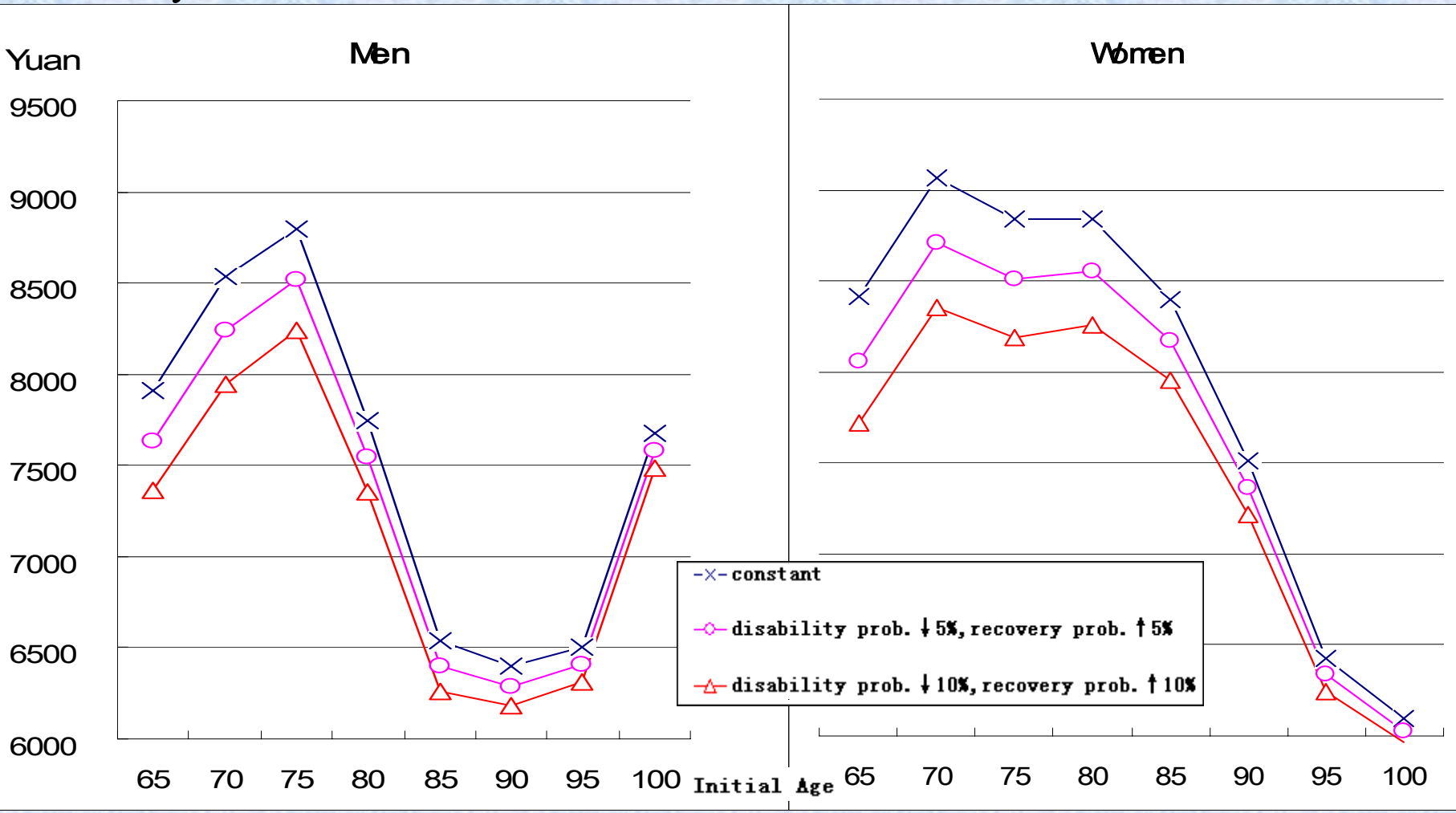
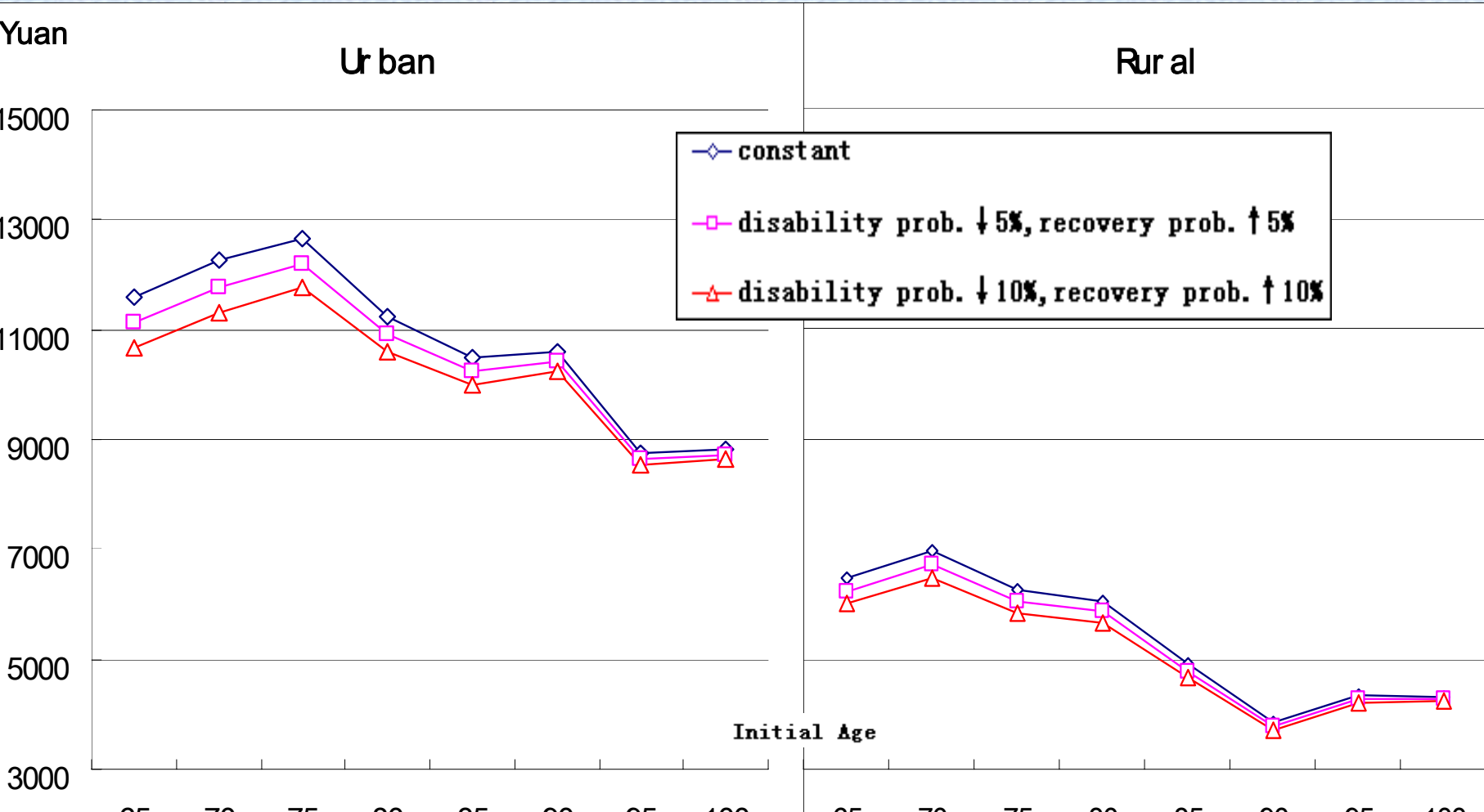
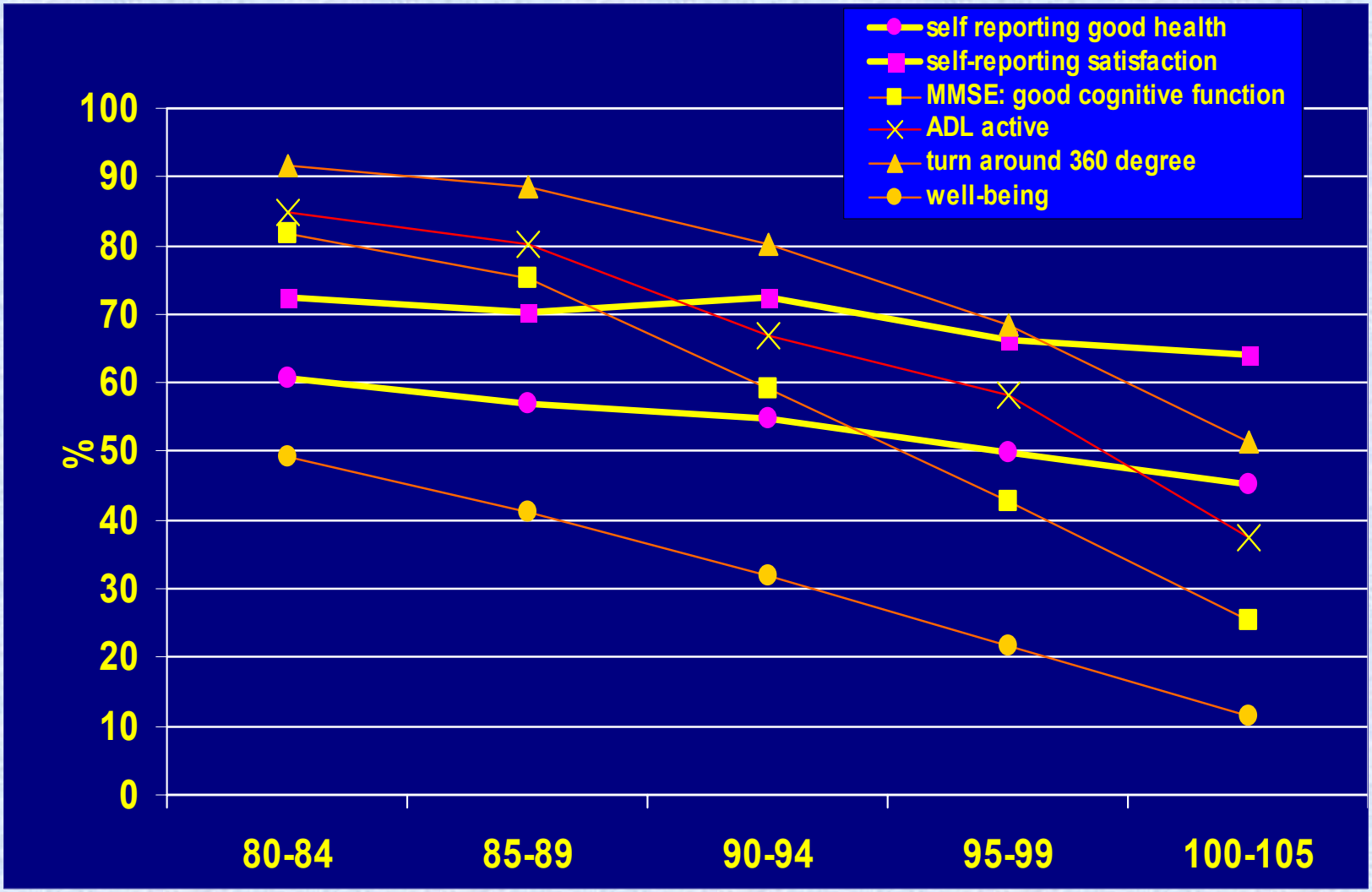


Figure 6. Average Expected Daily-life-Care Total Cost in the Rest of the Life of Chinese Elderly (Two sexes combined), with Different Scenarios of Reduction in Disability



## B2. Happiness is the key of healthy longevity

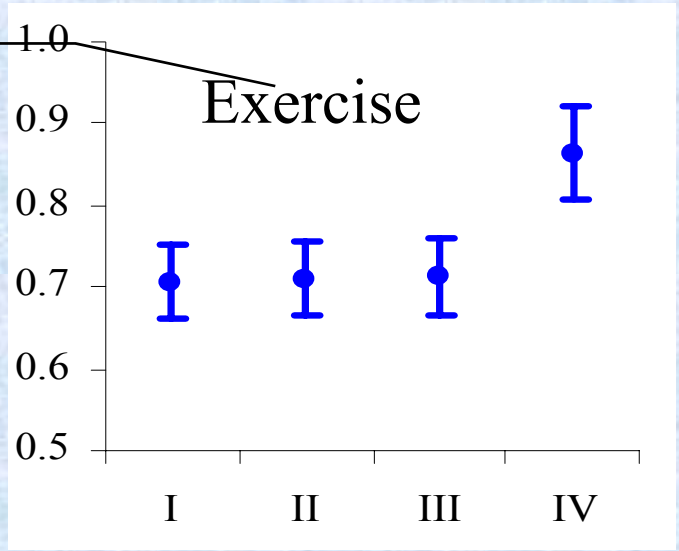
--- Zeng Yi and James W. Vaupel. 2002. "Functional Capacity and Self-Evaluation of Health and Life of the Oldest Old in China." *Journal of Social Issues, 58: 733-748.*

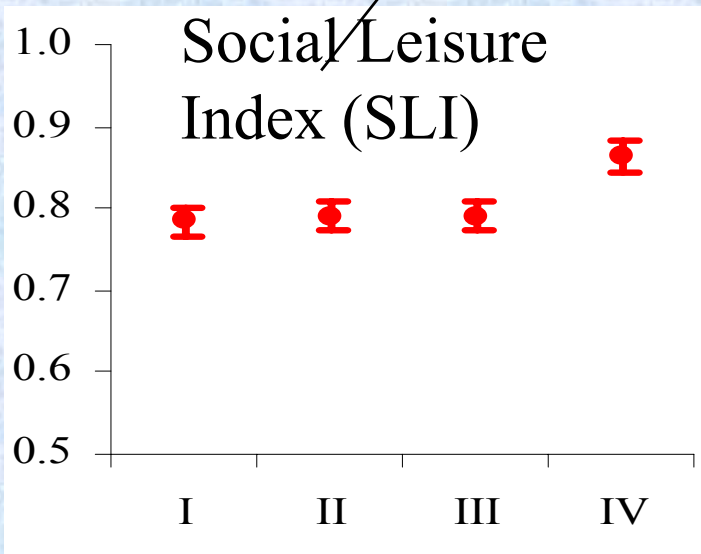


# B3.Exercise and Social/leisure activities enhance health and reduces mortality at old age

**Figure 2. Relative hazards of regular exercise and social leisure activities on 3-year mortality among the Chinese elderly, the CLHLS 2002-05**

Yes
vs
No



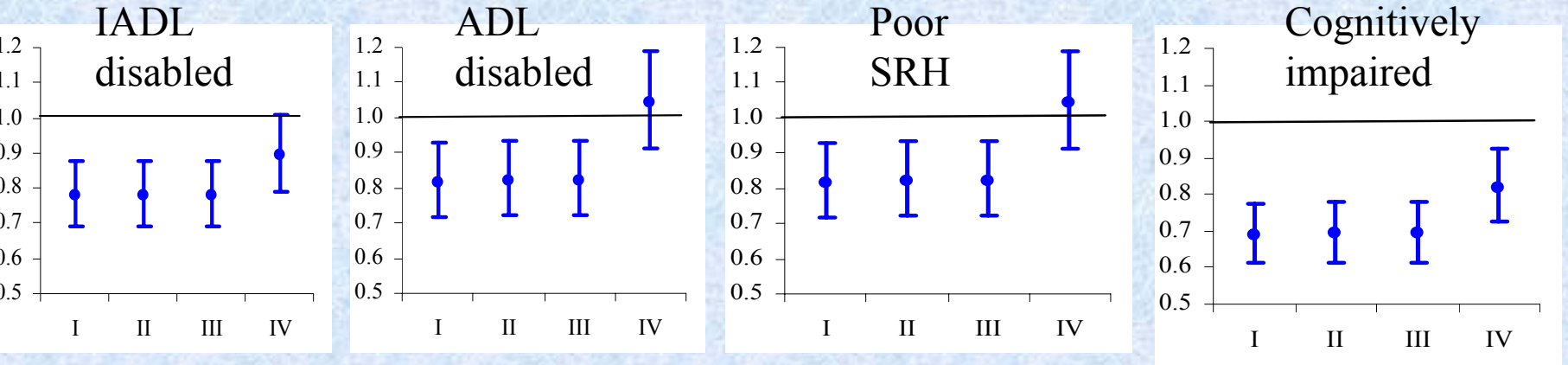

based on 7 dummy variables:
(1) gardening,
(2) personal outdoo activities,
(3) Reading,
(4) watching TV /listening to rad
(5) social activities
(6) raise poultry/pe
(7) playing cards /mah-jong.
**Scores: 0-7**

**Model I controls for demographic variables and SES; Model II adds family/social support; Model III adds health practice; Model IV adds Frailty index in 2002**

--- Doing regular exercise reduces the 3-year mortality risk by 30%; such effect reduced to 15% once baseline health (Frailty index) is controlled for.

--- Involvement in leisure activity reduces the mortality hazard by about 20%; Once the health status (Frailty index) in the last interview is adjusted for, the protective effects lower down to 15%

**Figure 3. Odds ratio of regular exercise on health status among the Chinese elderly, the CLHLS 2002-05**

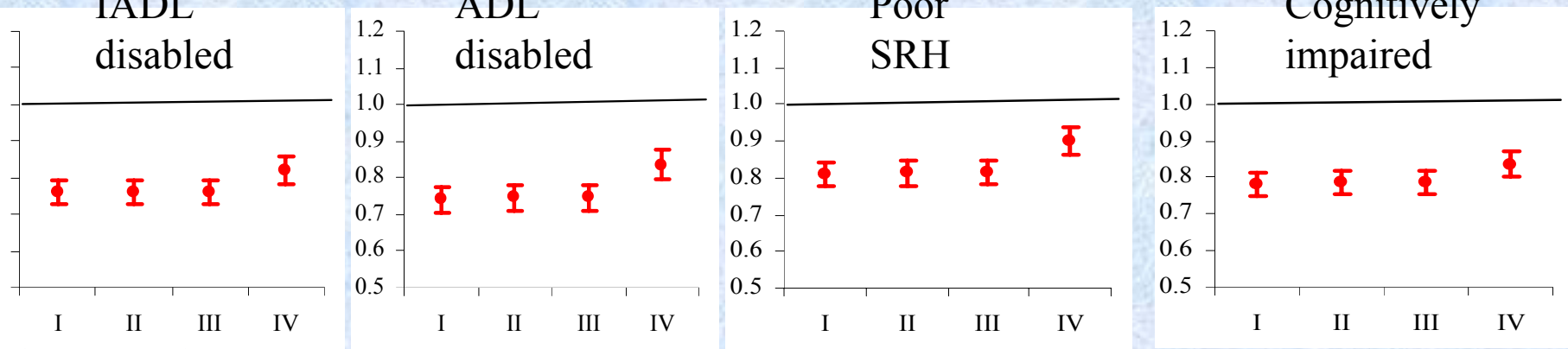



**(1) SRH: Self-rated health. (2) All dependent variables are measured in 2005. (3) Model I controls for demographic variables and SES; Model II adds family/social support; Model III adds health practice; Model IV adds Frailty index in 2002**

-- Regular exercise reduces IADL disability by 25%, ADL disability and poor SRH by 20%, and cognitive impairment by 30% in subsequent 3-year follow-ups without controlling for baseline (3-year ago) overall health.

-- Once overall health at baseline is controlled for, regularly exercise has no significant protection on ADL and SRH, but it still reduces IADL disability by 15% and cognitive impairment by 20%.

**Figure 4. Odds ratio of social/leisure activities on health status among the Chinese elderly, the CLHLS 2002-05**




**(1) SRH: Self-rated health. (2) All dependent variables are measured in 2005. (3) Model I controls for demographic variables and SES; Model II adds family/social support; Mode III adds health practice; Model IV adds Frailty index in 2002**

-- Social/leisure activities reduce odds of IADL disability, ADL disability and cognitive impairment by around 25%, and reduce poor SRH by 20%, without controlling for baseline (3-year ago) overall health status.

-- After overall baseline health status was controlled for, the effects of social/leisure activities on current heath status slightly reduced.

# B4. Better quality of marriage enhances health and reduce mortality at old age

Table 5 Odds Ratios of Marriage Quality on Frailty Index (FI) among the Chinese Elderly, the CLHLS 1998-2005

| | Models | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| ***Marriage Quality (current marriage)*** | | | | |
| Good VS No, Women (n=1,212) | **0.60**** | **0.61**** | **0.65**** | **0.67**** |
| Good VS N, Men (n=4,528) | **0.71***** | **0.70***** | **0.72***** | **0.72***** |
| ***Marriage Quality (past marriages))*** | | | | |
| Good VS No, Women (n=18,509) | **0.68***** | **0.69***** | **0.69***** | **0.69***** |
| Good VS N, Men (n=12,283) | **0.69***** | **0.69***** | **0.70***** | **0.71**** |

(1) The estimates are based multi-wave data (1998-2005). (2) Frailty index is generated from 30 variables measuring health and functional status in different aspects. We dichotomize FI into top 20% vs the rest 80%. (3) Model I adjusts for demographic variables only; Model II adds SES; Model III further controls for family/social support & connection; Model IV additional adjusts for health practice.

--- Good marriage reduces the risk of being in top 20% of Frailty Index by about 30-40% for both old women and old men

Table 6 Relative Hazards of Marriage Quality on Mortality among the Chinese Elderly, the CLHLS 1998-2005

| | Models | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| ***Marriage quality (current marriage)*** | | | | | |
| Good VS No, Women (n=3,181) | **0.68*** | **0.69*** | **0.74*** | **0.75+** | **0.85** |
| Good VS No, Men (n=11,565) | **0.88+** | **0.86*** | **0.88+** | **0.89** | **0.93** |
| ***Marriage quality (past marriages)*** | | | | | |
| Good VS No, Women (n=45,058) | **0.93**** | **0.93**** | **0.93**** | **0.93*** | **0.99** |
| Good VS No, Men (n=30,204) | **0.93*** | **0.93*** | **0.94+** | **0.95** | **1.01** |

(1) The estimates are based multi-wave data (1998-2005). (2) Frailty index is generated from 30 variables measuring health and functional status in different aspects. We dichotomize FI into top 20% vs the rest 80%. (3) Model I adjusts for demographic variables only; Model II adds SES; Model III adds family/social support & connection; Model IV adds health practice; Model V adds Frailty Index.

--- Good marriage reduces the mortality risk by 25-32% for old women and by 12% for men among the current married elders without controlling for Frailty Index; The protective effects disappear once Frailty Index (FI) is adjusted for.

--- Good marriage reduces the mortality risk by 6-7% for both old women and men among the ever married (but not currently married) elders without controlling for FI; The protective effects disappear once FI is adjusted for.

# B5.Daughter advantage in caring for old parents: CLHLS denies traditional son-preference

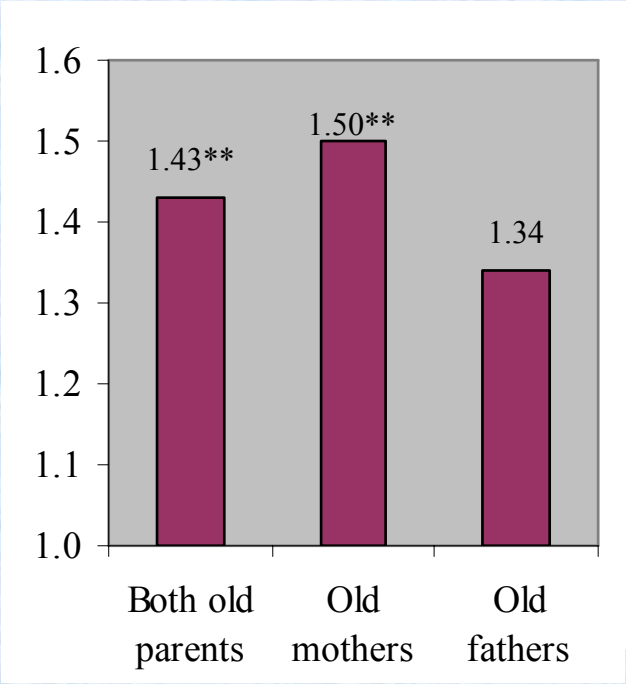
**Table 2. Odds ratios of adult children's self-reported emotional relation with elderly parents: daughters versus sons, based on the adult children's dataset in 2002, controlling for confounding factors**

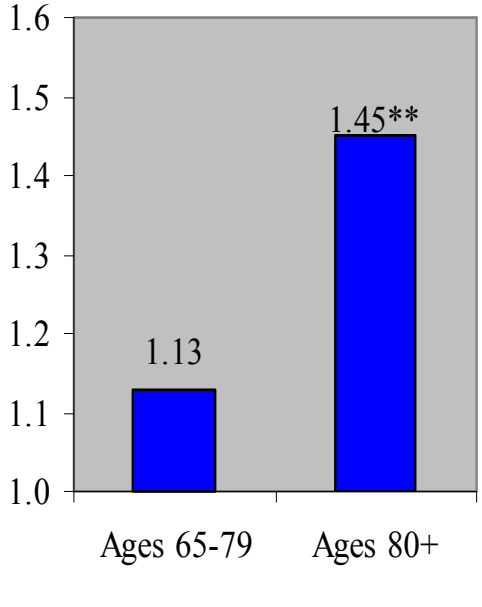
| Age rang/ residence of elderly parents | Ages 65+ | Ages 65-79 | Ages 80+ | Urban | Rural |
|---|---|---|---|---|---|
| Good emotional relation wh father (daughter VS son) | 1.29** | 1.31+ | 1.35* | 1.29* | 1.18 |
| Good emotional relation wh mother (daughter VS son) | 1.28** | 1.44** | 1.24+ | 1.16 | 1.32* |

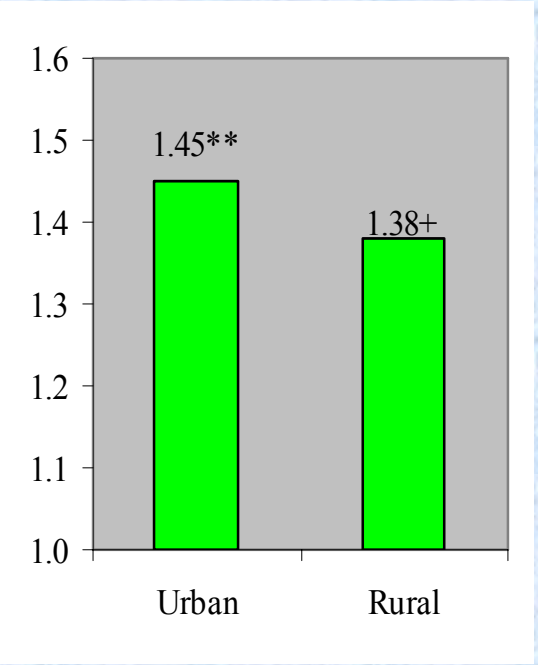
Notes: +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Summary of the results: As compared with adult sons, adult daughters' emotional relationships with parents are significantly better, and such daughter advantage for old parents is more profound among the rural elderly mothers, and among the oldest-old fathers.

**Figure 1. Odds ratios of old parents' satisfaction for care provided by the primary care-giver who is daughter versus who is son controlling for various confounding factors, based on cross-sectional data of CLHLS 2005, controlling for confounding factors**




Note: +, $p<0.1$; *, $p<0.05$; **, $p<0.01$

**Table 4. Odds ratio of health conditions among those elderly having daughter(s) only VS having son(s) only and those having daughter(s) & son(s) VS having son(s) only, based on data from CLHLS 1998-2005, controlling for confounding factors**

| Sequential model and covariates | Both sexes (obs= 44,097) | Females (obs= 25,402) | Males (obs =18,695) | Ages 65-79 (obs= 8,090) | Ages 80+ (obs= 36,007) | Urban (obs= 21,206) | Rural (obs= 22,891) |
|---|---|---|---|---|---|---|---|
| **Having daughter(s) only VS having son(s) only** | | | | | | | |
| ADL disabled | 1.07 | 1.09 | 1.01 | 1.49+ | 1.05 | 1.11+ | 1.05 |
| Cognitive impaired | 0.96 | 0.96 | 0.94 | 0.87 | 0.96 | 0.99 | 0.93 |
| Self-reported bad health | 0.96 | 0.93 | 1.01 | 1.06 | 0.96 | 1.00 | 0.92 |
| Self-reported bad life satisfaction | 0.90* | 0.86* | 0.99 | 1.21 | 0.89* | 0.94 | 0.86* |
| Frailty index | 0.97 | 0.96 | 0.97 | 1.21 | 0.96 | 1.02 | 0.93 |
| **Having daughter(s) & son(s) VS having son(s) only** | | | | | | | |
| ADL disabled | 1.04 | 1.04 | 1.04 | 1.13 | 1.04 | 1.10 | 0.99 |
| Cognitive impaired | 0.98 | 1.02 | 0.90 | 0.76 | 1.00 | 1.01 | 0.97 |
| Self-reported bad health | 1.12 | 1.12 | 1.12 | 1.03 | 1.13** | 1.17 | 1.08 |
| Self-reported bad life satisfaction | 1.06 | 1.09 | 1.00 | 0.94 | 1.06 | 1.03 | 1.07 |
| Frailty index | 1.06+ | 1.06 | 1.05 | 1.06 | 1.02 | 1.10 | 1.02 |

Notes: +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

**Summary of the results:** As compared to those elders who have son(s) only, the risk of reporting poor life satisfaction of those having daughter(s) only mostly reduced significantly, especially in rural areas and among elderly women and among oldest-old; Having or having no daughter(s) does not impose significant impacts on other health conditions of elderly;

Table 3. **Odds ratios of follow-up declining cognitive capacity among those elderly whose most frequently talking-persons in daily life are daughter & son-in-law VS son & daughter-in-law, based on data from CLHLS 2002-2005, controlling for confounding factors**

| Sequential models and covariates | Both sexes (n=7,124) | Females (n=3,704) | Males (n=3,420) | Ages 65-79 (n=3,564) | Ages 80+ (n=3,560) | Urban (n=3,204) | Rural (n=3,920) |
|---|---|---|---|---|---|---|---|
| I. Controlled for demographic factors and number of living children | 0.73* | 0.78+ | 0.59* | 0.52* | 0.78+ | 0.78 | 0.65* |
| II. Model I plus SES variables, marital status, | 0.76* | 0.80 | 0.64+ | 0.57* | 0.81 | 0.84 | 0.67* |
| III. Model II plus health practice | 0.76* | 0.80 | 0.65+ | 0.57* | 0.80 | 0.84 | 0.67* |

Notes: +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

**Summary of the results: As compared to son(s), daughters' talking (as the most frequent talker) to old parents significantly reduce the risk of follow-up declining cognitive capacity.**

Table 4. Relative hazard (RH) of mortality among those elderly having daughter(s) only VS having son(s) only and those having daughter(s) & son(s) VS having son(s) only, based on data from CLHLS 1998-2005

| Sequential model and covariates | Both sexes (n=21,845) | Females (n=12,737) | Males (n=9,108) | Ages 65-79 (n=4,257) | Ages 80+ (n=17,588) | Urban (n=9,231) | Rural (n=12,614) |
|---|---|---|---|---|---|---|---|
| **Having daughter(s) only VS having son(s) only** | | | | | | | |
| I. Gender of children plus demographic factors, SES variables, marital status, proximity to children, and number of living children | 0.92* | 0.92* | 0.94 | 1.06 | 0.92* | 0.98 | 0.88** |
| II. Model I plus health practices | 0.92* | 0.92+ | 0.93 | 1.06 | 0.92* | 0.97 | 0.89** |
| III. Model II plus Frailty Index | 0.93* | 0.93+ | 0.92 | 1.01 | 0.93* | 0.96 | 0.90 * |
| **Having daughter(s) & son(s) VS having son(s) only** | | | | | | | |
| I. Gender of children plus demographic factors, SES variables, marital status, proximity to children, and number of living children | 0.95 | 0.95 | 0.95 | 0.88 | 0.95 | 0.98 | 0.93 + |
| II. Model I plus health practices | 0.95 | 0.94 | 0.95 | 0.88 | 0.95 | 0.97 | 0.92+ |
| III. Model II plus Frailty Index | 0.94+ | 0.94 | 0.95 | 0.84 | 0.95 | 0.96 | 0.93 |

Notes: +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

**Summary of the results: As compared to having son(s) only, having daughter(s) only substantially reduces mortality risk at old ages in the 7-year follow-up period, especially so at oldest-old ages and in rural areas.**

- **Publicly predominated perceptions of depreciating the value of daughters and expecting that son(s) may provide better care to old parents, especially in rural areas in China, are people's incorrect imaginations based on traditional ideology, and they are not the reality.**

- **Aborting the girl fetal to insure having at least one son in the context of low fertility is not a rational choice of those people who did this, with respect to their own personal interests for better old age care from children.**

## Policy implication and recommendation:

- **While we need widely disseminate the research findings that having daughter(s) is beneficial in daily and emotional care and reducing long-term mortality risk at old ages, especially in rural areas and at oldest-old ages, the efforts of establishment of old age insurance program in rural China must be on the governmental social development priorities list. This will largely reduce farmers' needs and motivation of having at least one son for old age financial support.**
- **With wide disseminations of knowledge based on the scientific research and the establishment of the rural old age insurance program, the son-preference induced sex-selective abortions and the extremely dangerous trend of increasing sex ratio at birth can be reversed.**

# B6. Association of childhood socioeconomics with health status at oldest-old ages

-- multivariate logistic analysis found that receiving adequate medication during sick period or never be sick in childhood significantly reduces risk of being ADL impaired, cognitively impaired, and self-reporting poor health by 18%-31% at oldest-old ages.

-- The estimates of the other five indicators of childhood status have shown a positive association between childhood socioeconomic conditions with health status at oldest-old ages, although mostly not statistically significant.

## Association of childhood socioeconomics with two-year interval survival at oldest-old ages

**The multivariate survival analysis show that better childhood socioeconomic conditions in general tend to reduce the two-year period mortality risk among the oldest-old; but after additionally controlling for economics, family support, social connections, health practice, and healthy conditions, the effects become weak and not statistically significant.**

# B7. Impacts of community social and physical environmental factors or elderly health outcome --Multi-level & multivariate Statistical Analysis

**1. Multilevel logit regression: Dependent variables are health indicators of ADL, SRH, IADL, MMSE, One or more chronic diseases, Frailty Index (FI).**

Independent variables in Five sequential models

-- Model I: Community level factors + age, sex, ethnicity;

-- Model II: Model I + childhood SES;

-- Model III: Model II + adulthood SES;

-- Model IV: Model III + family/social support;

-- Model V: Model IV + health practice;

**2. Multilevel discrete hazard regression on 3-year mortality risk:** (Dependent variable: survival time in month)

Independent variables: community level factors plus confounders of age, sex, ethnicity, childhood SES; adulthood SES; family/social support; health practice; and frailty index in 2002.

# Community Factors Associated with FI

1. Higher employment reduced the frailty of elderly by 27-48%;
2. air pollution increase frailty of elderly by 10%;
3. Too hot temperature increase frailty of elderly by 56%
4. Living in hill and mountain areas reduce frailty of elderly by 45%

| | Model I | Model II | Model III | Model IV | Model V |
|---|---|---|---|---|---|
| Per capita GDP *RMB* 2000-5000 (<2000) | 1.03 | 1.02 | 1.03 | 1.00 | 1.01 |
| Per capita GDP *RMB* 5000-10000 (<2000) | 0.95 | 0.95 | 0.95 | 0.89 | 0.90 |
| Per capita GDP *RMB* 10000+ (<2000) | 0.95 | 0.95 | 0.95 | 0.91 | 0.91 |
| Illiteracy rate 5-10% (<5%) | 1.09 | 1.09 | 1.09 | 1.18 | 1.17 |
| Illiteracy rate 10%+ (<5%) | 1.06 | 1.06 | 1.06 | 1.17 | 1.17 |
| Employment rate 70-80%(<70%) | 0.76** | 0.76** | 0.76** | 0.72** | 0.73** |
| Employment rate 80%+ (<70%) | 0.60*** | 0.60*** | 0.59*** | 0.52*** | 0.52*** |
| Urban population 20-30% (<20%) | 0.98 | 0.98 | 0.98 | 0.95 | 0.94 |
| Urban population 30-40%(<20%) | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 |
| Urban population 40%+(<20%) | 0.97 | 0.97 | 0.98 | 0.99 | 0.98 |
| Air pollution index | 1.09* | 1.09* | 1.09* | 1.10* | 1.10* |
| Average temperature lower than –10 °C in January (no) | 0.94 | 0.94 | 0.94 | 1.00 | 1.01 |
| Average temperature higher than 29 °C in July (no) | 1.40** | 1.40** | 1.40** | 1.55** | 1.56** |
| Yearly rainfall 800-1200mm (<800mm) | 0.89 | 0.89 | 0.89 | 0.84 | 0.84 |
| Yearly rainfall 1200-1600mm (<800mm) | 0.98 | 0.99 | 0.99 | 0.96 | 0.97 |
| Yearly rainfall 1600mm+ (<800mm) | 1.07 | 1.08 | 1.08 | 0.98 | 1.00 |
| ≥70% of territory are hill and mountain areas (no) | 068* | 068* | 068* | 066* | 065* |

+p<0.1, *p<0.05, **p<0.01, ***p<0.001

# Community Factors Associated with ADL & IADL

1. Higher employment reduces ADL and IADL impairment by 18-45%;
2. Air pollution increase ADL impairment by 25%;
3. Too cold temperature increases ADL impairment by 31%
4. More rainfall decreases ADL impairment by 40-54%
5. Hill and mountain environment reduce ADL impairment by 49%.

| | IADL disabled | | | ADL disabled | | |
|---|---|---|---|---|---|---|
| | Model II | Model III | Model V | Model II | Model III | Model V |
| Per capita GDP *RMB* 2000-5000 (<2000) | 0.89 | 0.87 | 0.85 | 1.06 | 1.07 | 1.08 |
| Per capita GDP *RMB* 5000-10000 (<2000) | 0.94 | 0.93 | 0.91 | 1.12 | 1.12 | 1.14 |
| Per capita GDP *RMB* 10000+ (<2000) | 1.12 | 1.11 | 1.09 | 1.18 | 1.19 | 1.12 |
| Illiteracy rate 5-10% (<5%) | 0.95 | 0.95 | 0.93 | 1.11 | 1.11 | 1.15 |
| Illiteracy rate 10%+ (<5%) | 1.17 | 1.16 | 1.13 | 105 | 105 | 111 |
| Employment rate 70-80%(<70%) | 0.66** | 0.66** | 0.63*** | 0.84+ | 0.84+ | 0.82+ |
| Employment rate 80%+ (<70%) | 0.73* | 0.73* | 0.71* | 0.60*** | 0.60*** | 0.55*** |
| Urban population 20-30% (<20%) | 1.13 | 1.13 | 1.16 | 0.95 | 0.95 | 0.95 |
| Urban population 30-40%(<20%) | 1.26+ | 1.26+ | 1.33+ | 0.92 | 0.92 | 0.91 |
| Urban population 40%+(<20%) | 0.88 | 0.89 | 0.90 | 0.90 | 0.90 | 0.91 |
| Air pollution index | 1.06 | 1.06 | 1.07 | 1.22*** | 1.22*** | 1.25*** |
| Average temperature lower than –10 °C in January (no) | 0.77 | 0.77 | 0.73 | 1.24+ | 1.24+ | 1.31+ |
| Average temperature higher than 29 °C in July (no) | 1.21 | 1.22 | 1.20 | 1.06 | 1.06 | 1.10 |
| Yearly rainfall 800-1200mm (<800mm) | 0.88 | 0.88 | 0.86 | 0.65*** | 0.65*** | 0.60*** |
| Yearly rainfall 1200-1600mm (<800mm) | 0.94 | 0.94 | 0.94 | 0.64*** | 0.63*** | 0.59*** |
| Yearly rainfall 1600mm+ (<800mm) | 1.07 | 1.06 | 1.10 | 0.53*** | 0.53*** | 0.46*** |
| ≥70% of territory are hill and mountain areas (no) | 0.86 | 0.85 | 0.80 | 0.53*** | 0.53*** | 0.51*** |

+p<0.1, *p<0.05, **p<0.01, ***p<0.001

# Community Factors Associated with MMSE and SRH

1. Higher GDP reduces cognitive impaired & self-rep poor health by 19-40%
2. Higher employment rate reduced cognitive impairment by 24%
3. Too hot increases cognitive impairment and poor SPH by 33-50%;
4. Good rainfall reduced poor SRH by 25-39%

| | Cognitive impaired | | | Self-reported poor health | | |
|---|---|---|---|---|---|---|
| | Model II | Model III | Model V | Model II | Model III | Model V |
| Per capita GDP *RMB* 2000-5000 (<2000) | 0.72* | 0.71* | 0.70* | 0.81+ | 0.81+ | 0.80+ |
| Per capita GDP *RMB* 5000-10000 (<2000) | 0.69* | 0.69* | 0.67* | 0.85 | 0.85 | 0.83 |
| Per capita GDP *RMB* 10000+ (<2000) | 0.61** | 0.61** | 0.60** | 0.82 | 0.82 | 0.81 |
| Illiteracy rate 5-10% (<5%) | 1.16 | 1.16 | 1.18 | 1.07 | 1.07 | 1.09 |
| Illiteracy rate 10%+ (<5%) | 1.34* | 1.34* | 1.29* | 1.05 | 1.05 | 1.07 |
| Employment rate 70-80%(<70%) | 0.78* | 0.77* | 0.76* | 0.88 | 0.88 | 0.87 |
| Employment rate 80%+ (<70%) | 0.86 | 0.86 | 0.85 | 0.99 | 0.99 | 0.99 |
| Urban population 20-30% (<20%) | 1.05 | 1.04 | 1.05 | 0.99 | 0.99 | 0.98 |
| Urban population 30-40%(<20%) | 1.30* | 1.31* | 1.34* | 0.98 | 0.98 | 0.98 |
| Urban population 40%+(<20%) | 0.96 | 0.96 | 0.96 | 1.12 | 1.11 | 1.13 |
| Air pollution index | 1.10* | 1.10* | 1.11* | 1.03 | 1.03 | 1.03 |
| Average temperature lower than –10 °C in January (no) | 0.80 | 0.80 | 0.81 | 0.95 | 0.95 | 0.96 |
| Average temperature higher than 29 °C in July (no) | 1.31* | 1.31* | 1.33* | 1.45** | 1.45** | 1.50*** |
| Yearly rainfall 800-1200mm (<800mm) | 0.77* | 0.77* | 0.75* | 0.77** | 0.77** | 0.75** |
| Yearly rainfall 1200-1600mm (<800mm) | 0.96 | 0.96 | 0.97 | 0.65*** | 0.65*** | 0.63*** |
| Yearly rainfall 1600mm+ (<800mm) | 1.09 | 1.11 | 1.12 | 0.65*** | 0.65*** | 0.61*** |
| ≥70% of territory are hill and mountain areas (no) | 0.93 | 0.93 | 0.94 | 1.83*** | 1.85*** | 1.93*** |

+p<0.1, *p<0.05, **p<0.01, ***p<0.001

# Community Factors Associated with elderly mortality

1. Higher employment decreases the elderly 3-year mortality by 22%

2. Too cold temperature increased the elderly mortality by 36%.

| | Model I | Model II | Model III | Model IV | Model V | Model VI |
|---|---|---|---|---|---|---|
| Per capita GDP RMB 2000-5000 (<2000) | 1.08 | 1.08 | 1.09 | 1.10 | 1.10 | 1.10 |
| Per capita GDP RMB 5000-10000 (<2000) | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 |
| Per capita GDP RMB 10000+ (<2000) | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 |
| Illiteracy rate 5-10% (<5%) | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.92 |
| Illiteracy rate 10%+ (<5%) | 0.95 | 0.95 | 0.95 | 0.96 | 0.96 | 0.96 |
| Employment rate 70-80%(<70%) | 0.80** | 0.80** | 0.79** | 0.78** | 0.78** | 0.78** |
| Employment rate 80%+ (<70%) | 0.87 | 0.87 | 0.87 | 0.86 | 0.86 | 0.86 |
| Urban population 20-30% (<20%) | 1.02 | 1.02 | 1.01 | 1.02 | 1.02 | 1.02 |
| Urban population 30-40%(<20%) | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| Urban population 40%+(<20%) | 1.00 | 1.00 | 0.99 | 1.00 | 1.00 | 1.00 |
| Air pollution index | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Average temperature lower than –10 °C in January (no) | 1.30* | 1.31* | 1.31* | 1.35* | 1.35* | 1.36* |
| Average temperature higher than 29 °C in July (no) | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| Yearly rainfall 800-1200mm (<800mm) | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.12 |
| Yearly rainfall 1200-1600mm (<800mm) | 1.14 | 1.14 | 1.14 | 1.15 | 1.15 | 1.16 |
| Yearly rainfall 1600mm+ (<800mm) | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| ≥70% of territory are hill and mountain areas (no) | 0.89 | 0.89 | 0.88 | 0.89 | 0.89 | 0.89 |

+p<0.1, *p<0.05, **p<0.01, ***p<0.001

In general, our answer to the question raised in the beginning "Can Humans Achieve the Goal of Longer Life and Healthy Aging?" Is: YES.

However, we still know rather little about how.

**Future perspectives of CLHLS study:**

***Interdisciplinary study on social, behavior, environmental and genetic determinants of healthy longevity.***

**Any comments and suggestions are most welcome!**

# Thank You Very Much!