Trends in Function and Activity Limitations among Chinese Oldest-Old, 1998 to 2008

Linda G. Martin (corresponding author), PhD, lmartin@rand.org, RAND Corporation, 1200 South Hayes Street, Arlington, VA 22202-5050. 703-413-1100 , ext. 5465, 703-413-8111 (fax)

Qiushi Feng, PhD, National University of Singapore, socfq@nus.edu.sg

Robert F. Schoeni, PhD, University of Michigan, bschoeni@umich.edu

Yi Zeng, PhD, Duke University and Peking University, zengyi68@gmail.com

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ABSTRACT

BACKGROUND. Disability rates of older populations in some countries have declined in recent decades. China has the largest oldest-old population on earth, but information on its trends is lacking.

OBJECTIVE. To determine whether rates of limitations with physical functions and daily activities have declined recently among the Chinese population ages 80-105 and, if so, to investigate the factors associated with the decline.

METHODS. Multiple waves of the Chinese Longitudinal Healthy Longevity Survey are analyzed from 1998 to 2008 to estimate prevalence of limitations and logistic models of time trends including possible explanatory variables.

RESULTS. The prevalence of need for assistance with activities of daily living declined by an unadjusted rate of 3.3 percent per year from 1998 to 2008. The decline in inability to conduct instrumental activities of daily living from 2002 to 2008 was 1.9 percent per year. Males did not experience improvement in ability to carry out any of three physical functions over the same period, but females did. Among the variables often associated with trends in these outcomes were adequacy of medical care as a child, main occupation before age 60 in agriculture, and being of a moderate weight.

CONCLUSION. Members of this oldest-old cohort saw dramatic changes in China during their lifetimes, and their early- and mid-life experiences are reflected in trends in their late-life functioning.

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1. Introduction

With over 18 million people ages 80 and over, China was home to 17.3 percent of the world's 80 and over population in 2010 (United Nations 2011). Members of this group witnessed remarkable historical changes in their lives—from the uprising against the Qing Dynasty in 1911 to the war against the Japanese invasion of 1937-45, the civil war and communist revolution of 1946-49, the Great Leap Forward of 1958-61, the Cultural Revolution of 1966-76, and the market reform and economic growth of the last three decades. Have their health and functioning improved in recent years?

There is a well-established literature examining this question for the United States and several European countries. For the decades of the 1980s and 1990s, there is strong evidence that the proportion of older Americans with limitations in their daily activities declined substantially (Manton & Gu 2001, Freedman et al. 2004), although change appears to have plateaued in the last decade (Freedman et al. 2012). In Europe, late-life functioning has generally improved although results depend on the specific indicator tracked (e.g., Martin et al. 2012, Parker et al. 2008, Picavet & Hoeymans 2002, Sulander et al. 2006). The trends literature for Asia is thinner, primarily because of data limitations. The requirements for strong trend evidence are demanding, for example, data from the same survey for three or more time points spanning six or more years and no change in questionnaires and survey design across the study period (Freedman, Martin, & Schoeni 2002). At least two studies of Asian populations have met those standards: A four-wave study of Japanese ages 66 and older from 1993 to 2002 found

declines in difficulty with physical functions, instrumental activities of daily living (IADLs), and activities of daily living (ADLs) (Schoeni et al. 2006). An analysis of multiple waves of data for the 65 and over population of Taiwan found the trend in physical functional difficulties depended on the time period examined, but declines from 1993 to 2007 in difficulty with IADLs and no change from 1999 to 2007 in difficulty with ADLs (Martin, Zimmer, & Hurng 2011).

Data from five waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) provide the opportunity to assess trends in functioning of the population ages 80-105 from 1998 to 2008. We focus on three common indicators of old age health: ability to perform selected physical functions and IADLs and need for assistance with ADLs. Although these measures are not pure health measures, and IADLs and ADLs may especially be influenced by environmental modification and use of assistive technologies, they reflect, in part, underlying physical capacity (Verbrugge & Jette 1994). The great variety of data collected in the CLHLS also allows us to explore the extent to which trends over time in socio-demographic characteristics and early-, mid-, and late-life experiences are associated with the trends that we find.

1. **Methods**

2.1 Data

The CLHLS is a longitudinal survey whose initial focus in 1998 was on the 80 and over population in 22 of 31 provinces of China that represent 85 percent of the total population. An attempt was made to interview all the centenarians (including those in

institutions) in a randomly selected half of the counties and cities in each of the provinces. For each centenarian, a nearby octogenarian and nonagenarian were interviewed, and for each age from 80 to 99, respondents included roughly equal numbers of males and females. The resulting sample over-represents males and the very oldest. In follow-up waves in 2000, 2002, 2005, and 2008, surviving respondents were re-interviewed, and for decedents, new respondents of the same sex and similar age were recruited. For the 1998 wave, one percent of the interviews actually took place in 1999, and for the 2008 wave, five percent of the interviews took place in 2009. In our estimation of average annual rates of change below, we take into account differences in average intervals between survey waves.

Cross-sectional weights for each survey wave were calculated on the basis of the age, sex, and urban/rural residence distribution of the 22 provinces (Duke University Center for the Study of Aging and Human Development 2012). In our analysis, we use these weights, which were calculated for ages 80 to 105 years, and thus are treating the data as a time series of cross-sections. For 1998 to 2008, we have a pooled sample of 52,789 observations, and for 2002 to 2008, 33,012 observations. In all of our models, we control for residence in an institution, since the survey design may have resulted in an over-representation of people in their 80s and 90s living in institutions.

Given the advanced age of many of the respondents, proxy responses were allowed. In particular, interviewers noted if a proxy response was given for each of the function and

activity outcomes that we analyze here, and we use these proxy variables as controls in our models.

The top section of Table 1 shows for each survey wave, the weighted proportions of respondents who were female, members of five age groups, institutionalized, and represented by a proxy for specific outcomes. Over time, the population became more male and older. The proportion in in`stitutions declined substantially, but as noted earlier, this pattern may not reflect that for the population as a whole, but rather the sample design of the CLHLS.

2.2 Measures of Limitation

The CLHLS collected information on several stages of the disablement process. For the three waves from 2002 to 2008, respondents were asked about their ability to carry out three physical functions independently: walking one kilometer, carrying five kilograms, and continuously crouching and standing three times. We constructed a summary indicator of functional limitation that was coded as one if the respondent reported inability to do any of these three functions independently. The top panel of Table 2 presents by year and by sex the weighted proportions reporting limitations for each function and the summary indicator, as well as the mean number of limitations. Also shown for each is the percent change from 2002 to 2008, unadjusted for age, sex, institutionalization, or proxy reports. About 60 percent of both sexes taken together reported inability with at least one of the three functions, the most difficult of which was continuously crouching and standing three times. Females were more likely to report

inability than male, but the unadjusted change from 2002 to 2008 for females was -0.72 percent versus 0.02 percent for males. The mean number of functional limitations also declined for females at an unadjusted rate of almost one percent per year.

For the same three waves, respondents were asked about their ability to do independently five IADLs: visit neighbors, cook a meal, shop, do laundry, and take public transport. Our summary indicator of IADL limitation was coded as one if the respondent reported inability to carry out at least one of these five activities independently. As shown in the middle panel of Table 2, over half of the 80-105 weighted sample reported such inability. Inability with specific activities in 2008 ranged from 14 percent unable to visit neighbors to over half unable to take public transport by themselves. Again, the proportions are higher for females than for males, except for cooking and doing laundry. But for the summary outcome the unadjusted annual rate of change was greater for males than females: -2.62 percent versus -1.39 percent. Males especially made progress in doing laundry and cooking meals. For both sexes together, the unadjusted average annual rate of change for the mean number of IADL limitations was -2.44 percent, even greater than the change of -1.93 percent for being unable to do independently any of the five.

For all five waves from 1998 to 2008, respondents were asked about their abilities to do five ADLs without assistance: feed oneself, transfer to and from bed and chair, dress, go to the toilet, and bathe. We constructed a summary indicator of need for assistance with ADLs that was coded as one if the respondent reported need for help with one or

more of these five activities. As shown in the lower panel of Table 2, the most challenging activity was bathing. The unadjusted percent decline in the summary measure of ADL inability was almost twice as large for females as for males (-3.85 versus -1.97 percent, respectively). The unadjusted mean number of ADL limitations also declined substantially for both groups, but not at as great a rate as needing help with any of five ADLs.

For all three outcome measures, less than one-half of one percent of responses were missing, and we omitted these cases from our analyses.

2.3 Possible Explanatory Variables

The CLHLS inquired about a wide range of socio-demographic characteristics and health behaviors. In identifying variables that might be associated with trends in limitations, we focused on those that in the literature have been found to have a cross-sectional relationship with our outcomes of interest. We also examined the trends in the variables themselves, since assuming no change in cross-sectional relationships over time, a variable whose distribution does not change over time is unlikely to be associated with temporal trends in limitations.

Table 1 presents the variables that we considered, organized by those we include in our basic control models, those whose influence begins in early life, those from the middle of life, and those from late life. For each variable, we show the unadjusted weighted prevalence by survey year, an indication of whether the prevalence of the variable

changed significantly from 1998 to 2008 and from 2002 to 2008, and the percentage of responses that were missing for the longest period available. Significant change is assessed by a p value of less than 0.05 on a trend coefficient in a logit or linear regression model (for binary or continuous variables, respectively) with controls for trend (0=1998, 2=2000, 4=2002, 7=2005, 10=2008), age group, sex, and institutional residence.

Among early-life variables, there was an increase over at least one of the time periods for Han ethnicity, being a male first born, having a father whose main occupation was agriculture, being right-handed, and frequently going to bed hungry as a child. Variables whose prevalence declined were urban birth and receipt of adequate medical care as a child. There also was a downward shift in the educational distribution of the 80-105 population from 1998 to 2008, but no change from 2002 to 2008. The changes in father's occupation in agriculture, childhood hunger, and adequacy of medical care as a child are especially large for the 11-year period. The first two increased by more than 15 percentage points, and the last declined by 50 percentage points.

Among mid-life variables, there were increases in children ever born, main occupation before age 60 in agriculture and related fields, doing physical labor regularly, and using tap water for drinking at age 60, and a decline in receipt of adequate medical care at age 60. Again, the changes regarding agriculture occupation and medical care are large. The increase in the former is driven primarily by change for females, for whom the prevalence increased from 53 to 74 percent over 11 years.

Among late-life variables, there were increases in being married, urban residence, currently drinking tap water, and the highest two categories of self-reported body weight, and decreases in smoking now or ever and the lowest two categories of body weight. Notably, adequacy of current medical care decreased from 1998 to 2008, but increased from 2002 to 2008. As indicated in a note to Table 1, there was a slight change in question wording for this variable, which may have affected the trends.

Trends in explanatory variables were generally similar for males and females, but we mention here a few instances of variables that will be of particular interest in our results and for which the trends for males and females differed from those shown for both sexes. For 1998 to 2008, the second weight category (40-54 kg.) was down for males and up for females. For 2002 to 2008, for males, main occupation agriculture was flat. For females, there was not a decline in the second weight category or an increase in the top weight category for the later period.

Most of the variables have well under one percent missing values. A few—those having to do with adequacy of medical care in childhood and at age 60, childhood hunger, and body weight—are missing one to two percent. For each explanatory variable, we included (besides the variable itself) a related dummy variable indicating missingness. Because of the very small numbers, these variables indicating missingness in some instances perfectly predicted the outcome. In such instances, the estimation software

automatically dropped the variables indicating missingness, which resulted in the exclusion of a handful of cases for which values of the related variables were missing.

2.4 Statistical Analysis

We fit logit models for trends in limitations for each of our three summary measures of limitations, for both sexes combined, males, and females. Each model includes dummy variables for survey wave. For models of limitations in physical functions and IADLs, there are dummy variables for 2005 and 2008, with 2002 the omitted category. For ADL models, 1998 is the omitted category, and there are dummy variable for each of the other four survey waves. In our basic models, we include controls for age group (as indicated in Table 1), institutional residence, and female (for models including both sexes). We also include the relevant proxy response indicator for each outcome.

We use the estimated coefficients to calculate the predicted values of the outcome for each year for each observation. The means of these predicted values for each year are then used to calculate the average annual percent change in the outcome, controlling for the variables in our basic model and using the average survey intervals of 10.27 years from 1998 to 2008 and 6.28 years from 2002 to 2008.

After fitting the basic model for each outcome, we then add possible explanatory variables individually to the basic model to see if the estimated average annual percent change is substantially different. In the following, we report results for which the difference is more than 10 percent. So, for example, if the basic model yields a rate of

change of -1.00 percent, we highlight variables whose addition to the basic model results in an estimated rate of change smaller than -0.90 percent or greater than -1.10 percent.

For all models, standard errors are adjusted to account for multiple observations of some individual respondents across survey waves.

For ADL limitations for which we have data from 1998 to 2008, we checked sensitivity of our basic model results to excluding the first year and starting the analysis in 2000, but did not find substantial differences.

2. Results

Table 3 presents the results for physical functions. In the basic model for both sexes, the coefficient for year 2005 indicates a statistically significant decline from 2002, but the coefficient for year 2008 indicates no difference from 2002. The resulting estimated average annual change in inability to independently carry out at least one of the three physical functions is small, -0.48 percent. Among individual physical functions, for only carrying five kilograms is there a significant change from 2002 to 2008.

Five different variables when added to the basic model change the estimated average annual change by 10 percent or more. Increasing the size of the change are adequate medical care as a child (whose trend is down and whose main effect on inability is borderline negative with p=.054 (not shown)) and childhood hunger (whose trend is up

and whose main effect on inability is positive). Controlling for these variables results in larger estimated declines in functional inability than in the basic model, so had these variables not changed in a detrimental fashion there would have been greater improvement in physical functioning.

Reducing the size of the estimated average annual change in physical function inability are main occupation agriculture before age 60 (whose trend is up and main effect on inability is negative), adequate medical care now (whose trend is up and whose main effect on inability is negative), and body weight (whose trend is up and for which the main effects of the middle two weight categories on inability are negative in comparison to the omitted lowest category). So had there not been beneficial changes in these three variables, the improvement in functioning would have been smaller.

For males, neither of the coefficients on the year dummy variables is statistically different from zero, and the estimated average annual change in physical functional difficulty is only 0.21 percent. When variables were added to the basic model, both year dummy variables remained insignificant in all cases, so we do not report results from those models.

For females, the coefficients on both year dummy variables in the model for inability with any of three physical functions are significantly negative, indicating improved functioning from 2002 to 2008. There are also significant declines in inability for two of the individual measures, walking one kilometer and carrying five kilograms. The

estimated average annual change in the summary indicator is -0.78 percent. As in the case of both sexes combined, two variables increase the size of the estimated rate of decline by more than 10 percent, and three reduce it similarly.

Table 4 provides the results for trends in IADL inability. The coefficients on the two year dummy variables for the summary indicator for both sexes together are negative, large, and significant. The resulting estimated average annual change from 2002 to 2008 is -1.77 percent. The estimated changes for each sex are also substantial: -2.45 percent for males (although the dummy variable for 2005 is not significantly different from zero) and -1.45 percent for females. For both sexes together and for females, there are declines in inability for all five individual activities from 2002 to 2008, but for males, only for three activities—shopping, cooking, and doing laundry. For both sexes combined and for males, none of the possible explanatory variables have a substantial effect on the estimated average annual change. For females (for whom the proportion in the under 40 kilogram weight category is down and the proportion in the 55 to 64 kilogram category is up), adding body weight (for which the main effects of the middle two weight categories on inability are negative in comparison to the omitted lowest category) results in a smaller negative trend coefficient. Thus, the change in weight distribution had a beneficial effect on the IADL trend for females.

Results for trends in need for assistance with ADLs are presented in Table 5. For both sexes together, there is a significant negative coefficient on the dummy variable for 2008 and a resulting estimated average annual rate of change from 1998 to 2008 of

-3.91 percent. By 2008, need for assistance with all of the individual ADLs had declined significantly. One variable increases the size of the decline—adequate medical care as a child (whose trend is down and whose main effect on need for assistance is negative). Thus, the trend in this variable was not beneficial for ADLs. Two variables reduce the size of the rate of decline by more than 10 percent—main occupation in agriculture before age 60 (whose trend is up and whose main effect on need for assistance is negative) and body weight (whose trend is up and for which the main effect of the highest category versus the lowest on need for assistance is significantly positive).

The estimated average annual rate of decline from the basic model is almost 50 percent larger for females than males. When specific variables are added to the basic model, the results for males and females generally follow a pattern similar to that for both sexes. The exception is that for males the addition to the basic model of father's main occupation in agriculture (whose trend is up and whose main effect is negative) lowers the estimated rate of change by more than 10 percent, indicating that the trend in the variable was advantageous.

3. **Summary and Discussion**

The self-reported ability of the Chinese population ages 80 to 105 years to function and independently carry out daily activities increased substantially over the study period. Both sexes taken together and females experienced improvements in abilities to do physical functions, IADLs, and ADLs, while males showed improvement in the last two.

Early-, mid-, and late-life factors were associated with trends in physical functions and ADLs. Temporal decline in reported adequacy of medical care in childhood and increase in reported childhood hunger were associated with disadvantageous trends in late-life outcomes. The trend in childhood hunger was similar for all age groups, but adequacy of medical care in childhood especially deteriorated over time for age groups 80-84 and 100-105 (not shown). It could be that the younger group was affected by the war against the Japanese invasion of 1937-45. Those ages 80-84 in 1998 were born roughly in 1914-18, whereas those 80-84 in 2008 were born 1924-28, so would have still been children (ages 9 to 13 years) at the start of the war. The trend in adequacy of medical care in childhood for the 100-105 group may have been affected by the 1911 uprising. Those ages 100-105 in 1998 were born roughly 1893-98 and would have been ages 13 to 18 at the time of the uprising, but those 100-105 in 2008 would have been ten years younger. Other researchers using the same dataset have found significant early-life effects on late-life health and mortality (Huang & Ilo 2009, Wen & Gu 2011).

Greater father's employment in agriculture and greater own employment in agriculture before age 60 were beneficial and may be related to greater physical activity or access to food. The trends in body weight are also beneficial and reflect the changing nutritional patterns of recent decades in China (Zhai et al. 2009). Reported adequacy of current medical care increased from 2002 to 2008 and had advantageous effects on the trend in physical functioning especially for females. This result should be considered with some caution given the difference in question wording in 2002 versus 2005 and

2008, but the reported improvement in medical care is consistent with findings of a national study of care from 2003 to 2011 (Meng et al. 2012).

That education has no effect on the trends in functioning and daily activities is surprising in view of the important role that it has played in other populations (e.g., Martin et al. 2012; Martin, Zimmer, & Hurng 2011; Schoeni, Freedman, & Martin 2008). But in this cohort of older Chinese, there was actually decline in educational attainment over the study period, in contrast to the dramatic increase experienced elsewhere. This decline appears to be most substantial among males ages 100-105 (not shown). As in the case of adequacy of medical care as a child, education trends for this group may have been affected by conditions surrounding the 1911 uprising against the Qing Dynasty.

The paucity of variables associated with the trend in IADLs was disappointing, but the finding is similar to that of an analysis of IADLs from 1998 to 2008 among the 65 and over in Shanghai, China's largest city (Feng et al. 2012). We have not been able to control for changes in technology that might influence cooking and laundering or changes in environment and infrastructure that might be associated with shopping and using public transport. A recent study of late-life function in Taiwan (Martin, Zimmer, & Hurng 2011) found that such factors likely played important roles in the decline in difficulty with IADLs there.

One of the limitations of this study is the focus on summary measures of limitation. We have not examined in depth trends in individual functions or activities. Nor have we

taken into account trends in severity of limitation or number of limitations within each overarching type—physical functions, IADLs, and ADLs. As shown in Table 2, the unadjusted downward trends in the summary measures of limitation parallel unadjusted downward trends in counts of limitations, but in the case of ADLs, the decline in the mean numbers is not as great as for the decline in needing help with any of the five ADLs. Future analysis might benefit from greater attention to such detail and to examination of measures of physical performance.

Another study limitation is that we have had to rely on respondents' own characterizations of their earlier lives. It could be that with the recent rapid economic growth, early-life experiences have been viewed more critically over time, as expectations have risen. Such may especially be the case for childhood hunger and past adequacy of medical care. Nevertheless, at least for the latter, we have noted some plausible links between the trends that we found in these variables and historical events in China.

The major strength of this study is the documentation of trends in late-life function and activity limitations for the largest oldest-old population on earth. There is little doubt that members of this cohort of the oldest-old in China have lived through and survived many challenging periods in their lifetimes. Our analyses indicate that some of these early- and mid-life factors are not only associated in the cross-section with functioning at older ages, but also partially account for some of the observed trends between 1998 and 2008.

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Table 1. Weighted Prevalence and Trends in Explanatory Variables Considered in Analysis of Trends in Limitations
(% unless otherwise noted)

Explanatory Variables	1998	2000	2002	2005	2008	Significant Change[1] 1998-2008	Significant Change[1] 2002-2008	% missing longest period available
Basic Model								
Female	62.53	62.57	62.49	60.41	59.29	down	down	0.00
Age 80-84 years	66.45	66.56	66.79	68.51	65.29	--	down	0.00
Age 85-89 years	25.19	25.34	25.50	23.86	26.23	--		0.00
Age 90-94 years	7.08	6.58	6.36	6.38	6.89	--	up	0.00
Age 95-99 years	1.18	1.40	1.21	1.07	1.43	--	up	0.00
Age 100-105 years	0.10	0.12	0.13	0.17	0.15	up	up	0.00
Institutionalized	6.62	7.87	5.74	2.72	1.60	down	down	0.00
Proxy any of 3 functional limitations	na	na	18.65	14.06	17.98	na	--	0.00
Proxy any of 5 IADLs	na	na	18.97	14.41	18.27	na	--	0.00
Proxy any of 5 ADLs	11.22	19.92	19.98	15.79	17.09	up	na	0.33
Early Life								
Han ethnicity	92.41	93.73	94.05	94.51	94.31	up	--	0.19
Urban birth	17.47	11.72	12.90	15.09	11.62	down	--	0.10
Firstborn	34.74	34.72	35.52	34.44	34.44	--	--	0.96
Male first born	12.09	12.38	12.57	13.26	13.47	up	--	0.96
# of siblings (mean)	3.30	3.18	3.17	3.19	3.17	--	--	1.00
Father's main occupation agriculture	69.44	76.18	78.26	79.11	84.48	up	up	0.32
Adequate medical care as child[2]	81.65	67.60	50.49	37.76	31.15	down	down	1.97
Tap water as child	1.80	1.30	1.60	2.22	2.11	--	--	0.52
Right-handed	95.08	96.20	96.84	96.88	96.92	up	--	0.30
Childhood hunger	55.73	60.81	65.29	68.45	72.74	up	up	1.13
0 years of education	62.00	64.67	64.92	64.42	63.78	up	--	0.42
1 to 6 years of education	27.08	27.64	26.61	26.35	27.67	--	--	0.42
7 plus years of education	10.53	7.25	7.84	8.80	8.31	down	--	0.42
Mid Life								
Children ever born	4.55	4.53	4.57	4.66	4.68	up	--	0.97
Main occupation before age 60 agriculture	52.73	59.91	61.32	62.80	68.80	up	up	0.12
Physical labor regularly	78.49	81.94	81.77	81.77	82.42	up	--	0.23
Adequate medical care at age 60[2]	96.10	92.29	85.61	82.54	80.31	down	down	1.18
Tap water at age 60	24.26	19.24	21.84	26.87	25.12	up	up	0.29
Late Life								
Married	25.53	25.92	27.24	29.86	32.63	up	up	0.03
Urban	37.82	32.57	33.48	40.98	40.98	up	up	0.00
Adequate medical care now[3]	95.91	94.30	87.98	88.71	91.62	down	up	0.09
Tap water now	53.42	48.65	56.15	61.59	59.26	up	up	0.01
Smoke now	20.37	19.50	17.16	18.45	17.25	down	--	0.03
Smoke ever	35.42	35.68	32.90	35.18	33.36	down	--	0.15
Body weight < 40 kg[4]	16.73	17.48	14.09	9.85	10.22	down	down	1.84
Body weight 40-54 kg[4]	54.69	58.78	60.87	58.18	55.90	--	down	1.84
Body weight 55-64 kg[4]	17.10	15.49	18.07	21.16	22.62	up	up	1.84
Body weight $\geq$ 65 kg[4]	8.18	6.63	6.96	10.37	10.65	up	up	1.84

na = not applicable

[1] Significance of trends based on a p value of <0.05 for the coefficient on a trend variable (0=1998, 2=2000, 4=2002, 7=2005, 10=2008) in a logit or linear regression model (as appropriate) with controls for trend, age groups, sex, & institution (unless the variable is the outcome variable). Sample sizes including missing are 52,789 for 1998-2008 and 33,012 for 2002-2008.

[2] For 1998-2005, "never sick" was a response category, in addition to "yes" and "no." These responses have been categorized as "yes."

[3] The question wording for all years except 2002 is "Can you get adequate medical services when you are sick?"
For 2002, the wording is: "Can you get adequate medical services when you are seriously ill?"
For 1998-2000, "never sick" was a response category, in addition to "yes" and "no." These responses have been categorized as "yes."

[4] For models of trends in function and activity limitations, a cubic specification of body weight is used, since it has a stronger association with those trends.

Table 2. Percent with Limitations in Physical Functions and Daily Activities, Mean Counts, and Unadjusted Change, Ages 80 to 105 by Sex (weighted)

	Both Sexes (n=33,012; 0.00% missing)						Males (n=13,069; 0.00% missing)						Females (n=19,943; 0.00% missing)					
Physical Function Inability	1998	2000	2002	2005	2008	unadjusted % change 2002-2008	1998	2000	2002	2005	2008	unadjusted % change 2002-2008	1998	2000	2002	2005	2008	unadjusted % change 2002-2008
Walk 1 km			45.09	41.13	42.17	-1.07%			33.30	32.21	33.20	-0.05%			52.17	46.98	48.33	-1.22%
Carry 5 kg			46.40	42.39	42.81	-1.28%			31.26	30.35	30.07	-0.62%			55.49	50.28	51.55	-1.17%
Crouch & stand 3 times			52.03	50.40	50.25	-0.55%			40.68	41.73	40.94	0.10%			58.85	56.08	56.63	-0.61%
Any of the 3			63.78	59.33	61.14	-0.67%			49.18	49.05	49.24	0.02%			72.54	66.07	69.32	-0.72%
Mean number of functional limitations			1.44	1.34	1.35	-0.95%			1.05	1.04	1.04	-0.16%			1.67	1.53	1.57	-0.98%

	Both Sexes (n=33,012; 0.02% missing)						Males (n=13,069; 0.00% missing)						Females (n=19,943; 0.04% missing)					
IADL Inability	1998	2000	2002	2005	2008	unadjusted % change 2002-2008	1998	2000	2002	2005	2008	unadjusted % change 2002-2008	1998	2000	2002	2005	2008	unadjusted % change 2002-2008
Visit neighbors			16.80	15.93	14.13	-2.75%			11.41	13.05	11.49	0.11%			20.03	17.81	15.94	-3.64%
Cook a meal			30.95	28.39	25.73	-2.94%			31.83	28.70	25.78	-3.36%			30.42	28.18	25.69	-2.69%
Shop			32.37	28.77	26.82	-2.99%			22.62	21.72	19.15	-2.65%			38.22	33.39	32.08	-2.79%
Do laundry			32.84	29.85	26.02	-3.70%			35.18	31.67	27.00	-4.21%			31.44	28.65	25.35	-3.43%
Take public transport			56.35	52.23	52.52	-1.12%			41.67	38.63	39.77	-0.74%			65.15	61.14	61.28	-0.97%
Any of the 5			63.73	58.25	56.45	-1.93%			53.54	49.36	45.42	-2.62%			69.85	64.07	64.02	-1.39%
Mean number of IADL limitations			1.69	1.55	1.45	-2.44%			1.43	1.34	1.23	-2.34%			1.85	1.69	1.60	-2.30%

	Both Sexes (n=52,789; 0.28% missing)						Males (n=21,210; 0.34% missing)						Females (n=31,579; 0.25% missing)					
ADL Need for Assistance	1998	2000	2002	2005	2008	unadjusted % change 1998-2008	1998	2000	2002	2005	2008	unadjusted % change 1998-2008	1998	2000	2002	2005	2008	unadjusted % change 1998-2008
Feed self	3.88	5.56	4.55	3.84	3.64	-0.62%	2.84	4.15	3.62	3.84	3.22	1.22%	4.50	6.40	5.11	3.83	3.93	-1.32%
Transfer	5.64	5.51	6.24	5.79	4.56	-2.07%	4.67	4.64	4.62	5.46	3.58	-2.59%	6.22	6.03	7.21	6.00	5.23	-1.69%
Dress	6.08	6.36	7.37	6.46	5.31	-1.32%	5.24	5.49	6.17	6.24	4.62	-1.23%	6.58	6.88	8.09	6.60	5.78	-1.26%
Toilet	7.01	6.89	8.01	6.92	5.52	-2.33%	5.60	5.97	5.98	6.30	4.51	-2.11%	7.85	7.44	9.24	7.32	6.21	-2.28%
Bathe	14.39	16.85	18.08	15.4	10.64	-2.94%	11.10	14.51	14.03	12.15	9.36	-1.66%	16.36	18.25	20.51	17.53	11.52	-3.42%
Any of the 5	16.31	19.02	20.24	16.07	11.62	-3.30%	12.92	16.09	16.07	12.66	10.55	-1.97%	18.35	20.77	22.74	18.30	12.36	-3.85%
Mean number of ADL limitations	0.37	0.41	0.44	0.38	0.30	-2.18%	0.30	0.35	0.34	0.34	0.25	-1.53%	0.42	0.45	0.50	0.41	0.33	-2.36%

Table 3. Estimates from Logit Models of Trends in Inability in Any of Three Physical Functions, Both Sexes, Males, and Females, 2002-2008

		Both Sexes	Males	Females
Coefficient (p) from basic model [1]				
	year 2005	-0.129 (.028)	0.049 (.531)	-0.264 (.002)
	year 2008	-0.087 (.113)	0.027 (.713)	-0.175 (.028)
Estimated average annual change		-0.48%	0.21%	-0.78%
Significant decline for inability with individual functions				
	2005 vs. 2002	--	--	walk 1km & carry 5kg
	2008 vs. 2002	carry 5kg	--	walk 1km & carry 5kg
Estimated average annual change for basic models with specific variable added that results in a change in the estimated average annual change of 10% or more [2]				
	adequate medical care as child	-0.59%		-0.89%
	childhood hunger	-0.59%		-0.87%
	main occupation agriculture before 60	-0.41%		-0.68%
	adequate medical care now	-0.38%		-0.69%
	body weight [3]	-0.39%		-0.68%

[1] Basic model includes year dummy variables, age groups, sex (omitted for sex-specific models), institutionalized, and proxy for responses to any of the physical function questions.

[2] For males, the coefficients on the year dummy variables were not significantly different from zero in any of the models, so we do not report change results here.

[3] Body weight is specified as weight, weight squared, and weight cubed in the models.

Table 4. Estimates from Logit Models of Trends in Inability in Any of Five IADLs, Both Sexes, Males, and Females, 2002-2008

		Both Sexes	Males	Females
Coefficient (p) from basic model [1]				
	year 2005	-0.170 (.000)	-0.124 (.125)	-0.207 (.013)
	year 2008	-0.305 (.000)	-0.325 (.000)	-0.294 (.000)
Estimated average annual change		-1.77%	-2.45%	-1.45%
Significant decline (unless noted otherwise) in ability for individual functions				
	2005 vs. 2002	--	visit (up)	--
	2008 vs. 2002	all 5	shop, cook, launder	all 5
Estimated average annual change for basic models with specific variable added that results in a change in the estimated average annual change of 10% or more				
	body weight [2]			-1.27%

[1] Basic model includes year dummy variables, age groups, sex (omitted for sex-specific models), institutionalized, and proxy for responses to any of the physical function questions.

[2] Body weight is specified as weight, weight squared, and weight cubed in the models.

Table 5. Estimates from Logit Models of Trends in Needing Assistance with Any of Five ADLs
Both Sexes, Males, and Females, 1998-2008

		Both Sexes	Males	Females
Coefficient (p) from basic model [1]				
	year 2000	0.013 (.850)	0.031 (.752)	0.001 (.989)
	year 2002	0.121 (.059)	0.082 (.411)	0.139 (.092)
	year 2005	-0.067 (.351)	-0.159 (.154)	-0.024 (.792)
	year 2008	-0.521 (.000)	-0.383 (.000)	-0.600 (.000)
Estimated average annual change		-3.91%	-2.98%	-4.42%
Significant decline for inability with individual functions				
	2000 vs. 1998	dress, transfer, & toilet	dress & transfer	transfer & toilet
	2002 vs. 1998	--	--	--
	2005 vs. 1998	--	--	--
	2008 vs. 1998	all 5	all except feed self	all 5
Estimated average annual change for basic models with specific variable added that results in a change in the estimated average annual change of 10% or more				
	father's main occupation agriculture	--	-2.66%	--
	adequate medical care as child	-4.88%	-3.94%	-5.39%
	main occupation agriculture before 60	-3.39%	-2.66%	-3.85%
	body weight [2]	-3.47%	-2.60%	-3.96%

[1] Basic model includes year dummy variables, age groups, sex (omitted for sex-specific models), institutionalized, and proxy for responses to any of the physical function questions.

[2] Body weight is specified as weight, weight squared, and weight cubed in the models.