A Comparison of Educational Differences on Physical Health, Mortality and Healthy Life Expectancy in Japan and the United States

Chi-Tsun Chiu¹*, Mark Hayward², Yasuhiko Saito³

¹Institute of European and American Studies, Academia Sinica, Taiwan
²Population Research Center and Department of Sociology, University of Texas at Austin, USA
³University Research Center, Nihon University, Japan

*Corresponding Author:
Chi-Tsun Chiu
Institute of European and American Studies, Academia Sinica,
No. 128, Sec. 2, Academia Rd., Nangang Dist., Taipei City 115, Taiwan
Email: ctchiu@gate.sinica.edu.tw

Abstract

The inverse relationship between education and health is well documented, and education has been viewed as a “fundamental cause” of health disparities. However, most of these studies are based on populations in the United States and Europe. We know less about education and health/mortality inequalities in a comparative context. It is particularly important to investigate the relationship in different national settings given the growing influence of the “fundamental cause” perspective on health and mortality. This study uses the Nihon University Japanese Longitudinal Study of Aging and the Health and Retirement Study to compare educational gradients on multiple aspects of health between two countries in terms of life expectancy within/without disability, functional limitations, or chronic diseases via prevalence-based Sullivan life tables. Our results show that education coefficients from physical health and mortality models are similar for both Japan and USA populations, and older Japanese have better mortality and health profiles.
Introduction

The inverse relationship between education and health is well documented in previous literature (Kitagawa and Hauser 1973; Montez et al. 2012; Ross and Wu 1995, 1996), and education has been viewed as a “fundamental cause” of health disparities (Link and Phelan 1995; Phelan and Link 2005). In addition, computations of healthy life expectancy highlight the correlation between better-educated people and longer healthy life expectancy (Crimmins et al. 1996; Crimmins and Saito 2001; Jagger et al. 2007). However, most of these studies are based on populations in Western countries. The relationship between education and health/mortality in non-Western countries is less clear. Some studies using data from countries in East Asia, for example, find mixed support for the relationship between education and health/mortality (Liu et al. 1998; Liu et al. 1995; Saito et al. 2012; Yong and Saito 2012; Zimmer et al. 1998). Therefore, we know less about education and health/mortality inequalities in a comparative context. It is particularly important to investigate the relationship in different national settings given the growing influence of the “fundamental cause” perspective on health and mortality. Cross-national comparison is crucial, because it can show the generalizability of the education-health/mortality relationship and thus promote theoretical development and empirical testing of the broader social forces that shape population-level health/mortality inequalities (Beckfield and Krieger 2009).

Because education potentially has distinct influences on different dimensions of health and mortality (Cutler and Lleras-Muney 2006), it is essential to examine multiple domains of health along with mortality to get a more complete picture of the relationship, especially using a
cross-national comparative approach. Therefore, this study compared educational gradients on multiple aspects of health between Japan and the United States in terms of life expectancy within/without disability, life expectancy within/without functional limitations, and life expectancy within/without major chronic diseases via prevalence-based Sullivan life tables. The Nihon University Japanese Longitudinal Study of Aging (NUJLSOA, 1999-2009) and the Health and Retirement Study (HRS, 1998-2010) are used to examine between-national differences in educational gradients of physical health and mortality.

**The Influence of Education on Health**

Consistent evidence for the strong association between education and health/mortality has been provided in previous studies. Since the work of Kitagawa and Hauser (1973), numerous studies have found that better educated people are more likely to have better health and longer lives (Mirowsky and Ross 2003; Ross and Wu 1995). Longitudinal studies on older ages also document that educational attainment is associated with onset and recovery of ill health (Herd et al. 2007; Jagger et al. 2007; Melzer et al. 2001; Zimmer and House 2003). In addition, computations of healthy life expectancy show the socially advantaged, as measured by years of education, spend more years in an active or healthy state (Crimmins et al. 1996; Crimmins and Saito 2001; Jagger et al. 2007). In sum, a persistent positive and robust relationship between education and a variety of health measures and longevity has been shown, across age groups, cohorts and time periods (Cutler and Lleras-Muney 2006; Lynch 2003; Masters et al. 2012; Mirowsky and Ross 2003). However, most of these studies finding a significant educational gradient on health and mortality is done within Western settings, especially the United States. The relationship between education and health/mortality in non-Western countries is less clear. The robust education–health association found in Western countries, for example, is not fully
supported in East Asian countries. On the one hand, studies of health in Asian countries report that better educated persons have a considerably lower death rate at older ages (Liang et al. 2002; Liu et al. 1998), have a lower incidence of disability or functional limitations (Liu et al. 1995; Yong and Saito 2012; Zimmer et al. 1998), but have little influence on recovery from disability or functional limitations (Liu et al. 1995; Yong and Saito 2012; Zimmer et al. 1998). On the other hand, Yong and Saito (2012) also show that education has no statistically significant (p<0.05) influence on transitions from disabled or nondisabled to mortality for elderly Japanese, and that the educational gradient in healthy life expectancy is relatively small. In addition, no study to date has systematically compared the magnitude of the educational gradients in health and mortality between Japan and the United States. A careful documentation of these differences is essential to better understand what might account for these differences.

Previous studies documenting the association between education and health in Western settings point to the importance of the following pathways: (a) work and economic conditions, (b) social-psychological resources, and (c) health behaviors and lifestyle choices (Lynch 2003; Ross and Wu 1995). That is to say, well-educated people are more likely to be employed with full-time jobs, have fulfilling work, high incomes and low economic hardship, and all of these are associated with better health. Highly educated persons also have a higher sense of personal control and social support; they are likely to have healthier lifestyles, such as to exercise, drink moderately, receive preventive medical care, and they are less likely to smoke (Cutler and Lleras-Muney 2006, 2010; Ross and Mirowsky 1995). In East Asia, there may be some other factors that mediate or moderate the links between education and health/mortality.

Although the link between education and health/mortality is weaker in Japan than in the U.S. (Yong and Saito 2012), education still plays an essential role in Japan’s society. For
example, Tachibanaki’s work showed that education is one of the key determinants in the hierarchy (promotion process or job ranks) of an organization and one of the most important factors in explaining personal earnings distribution (Tachibanaki 1987, 1988).

Education can affect paid employment and, therefore, economic well-being (Ross and Mirowsky 1999). However, due to mandatory retirement (teinen taishoku) policies that govern the retirement for most wage employees, elderly Japanese are required to retire at age 60 and find other jobs until age 65 in order to receive a pension. New jobs may be in another branch of the same organization, or self-employment (Raymo et al. 2009; Raymo et al. 2004). Many elderly Japanese continue to work after age 65 for many reasons, such as economic necessity and cultural characteristics (Williamson and Higo 2007). In the U.S in 2000, the labor force participation rates for people above age 65 were only 18% and 9% for men and women, respectively. In Japan in 2000, however, the labor force participation rates for people above age 65 were 35% and 14% for men and women, respectively (Raymo et al. 2009). Raymo et al. (2004) indicated that 44% of male and 53% of female labor force participants aged 60 and over were self-employed in 2000. This relatively high proportion of self-employment among elderly Japanese may be part of the reason that there is a relatively weak link between education and health/mortality in Japan.

Although Japan has achieved a high level of socioeconomic development that competes with Western countries, Japan still retains the traditional family structure. Therefore, it is still very common for elderly Japanese to live with their children, which is rarely the case in the United States (Kamo and Zhou 1994; Raymo et al. 2009). Brown et al. (2012) showed that, in 1996, 52% of elderly Japanese lived with their children. However, large families have both pros and cons related to intergenerational interactions that can affect elderly health. For example,
providing care for grandchildren vs. receiving care from adult children, providing or receiving financial support, and experiencing emotional stress or a buffer from it are important considerations.

A noteworthy contrast between Japan and the United States is the pace of social, demographic and epidemiological change during the 20th century, especially after WWII. These changes included a dramatic drop in fertility to below replacement levels and increases in age at marriage, life expectancy, levels of education (especially among females), employment among women, and levels of urbanization. Many of these trends have been implicated in the reduction in the prevalence of extended households. Gradually, more and more elderly people live with an elderly couple or live alone. This increasing Westernization is likely to have important consequences in the future for Japanese social environments and the economic status of the elderly, and therefore, their health and mortality (Beckett et al. 2002). In that sense, Japan may be in a “transition phase” in which patterns such as the education-health/mortality gradient may be less evident than in the United States. However, these patterns might become stronger in future cohorts.

**Goals for the Study**

Two modern countries share certain demographic characteristics among them. These are a high life expectancy, a high level of industrialization, and high GDP per capita. However, they also have very different socioeconomic backgrounds, especially with respect to educational attainment, which inevitably affects older adults’ health. It is very important to understand the educational gradient of health across these populations, which could provide further information about health disparities that is useful for policy and practice and about possible improvements in
the health of the population in the future (Yong and Saito 2012). In addition, because people live longer, the health-related quality-of-life issue has been brought into focus. Attaining the same length of life does not mean enjoying the same quality of life. People living in long-lived countries are starting to emphasize how many years and what proportion of their lifespan are spent in good versus poor health. Therefore, it is necessary to compare the educational gradient of health and mortality by looking at the concept of health expectancy cross-nationally. Health expectancy is a summary measure of population health that takes into account both current mortality and morbidity levels, and partitioning years of life lived at a particular age into healthy and unhealthy years (Yong and Saito 2009).

Therefore, this study examined the educational gradient of health and mortality between two long-lived populations: Japan and the United States, countries with diverse cultures, health systems, population composition and phases of epidemiologic and demographic transition. Since the Japanese have fewer years of formal schooling than Americans, when comparing between the two countries, it provides a good chance to look at a broader education spectrum and see the increments going from no formal education to college and beyond. Could the less robust relationship between education and health/mortality seen in Japan be due to an overall lower education of the elderly? Montez et al. (2012) use nationally representative American data to show that the educational gradient of mortality is much steeper after a high school diploma, but rather flat before a high school diploma. In the Japanese data set, Nihon University Longitudinal Study of Aging (NUJLSOA), over 60% of elderly Japanese (for both sexes) at first wave had less than a high school degree (Yong and Saito 2012). Therefore, elderly Japanese people have lower educational attainment than Americans. If elderly Japanese people had the same level of education as elderly American people, could they have the same health and mortality outcome?
If elderly Japanese had similar levels of education as elderly Americans, would they end up having a similar educational gradient on health and mortality? Or, is the education gradient really smaller in Japan even with the same educational attainment as Americans?

In order to answer these questions, the specific aims of this study are to:

1. Compare systematically the educational gradient of the mortality regimes in Japan and the United States.
2. Compare systematically the educational gradient of physical health (disability/functional limitation/chronic conditions) regimes in Japan and the United States.
3. Evaluate educational differences on mortality and physical health in terms of healthy life expectancy.

Methods

Data

Data on Japanese mortality and physical health are from the Nihon University Japanese Longitudinal Study of Aging (NUJLSOA) which is a longitudinal survey of a nationally representative sample of the population aged 65 and over in Japan. The first observation wave was initiated in 1999 (n = 4,997) and the overall response rate for that survey was 74.6%. The follow-up surveys were conducted in 2001, 2003, 2006 and 2009. The sample was also refreshed in 2001 and 2003 for those aged 65 and 66. The NUJLSOA sample in 1999 included community dwellers only, but the following surveys included also survivors followed into the institutions and, thus, cover part of the institutionalized population. The NUJLSOA survey was designed to
be comparable to the U.S. Longitudinal Study of Aging and the AHEAD sample of the HRS. Unlike previous studies that used the panel data starting from 1999 and excluded the refreshed sample (Oksuzyan et al. 2010; Yong and Saito 2012), this study makes use of all observation waves to investigate the changes in physical health status and mortality incidence for the Japanese non-institutionalized population. The analytical sample is age 65 and over in this study. The birth years of the analytical sample ranged from the turn of the 20th century to the 1940s, a period during which Japan went through rapid economic growth, fast demographic transition, and fast epidemiologic transition.

Data on morbidity and mortality for the United States is from the Health and Retirement Study (HRS), a biennial survey beginning in 1992. The institutional population was not initially included in the HRS sample at the time of the first interview, but the longitudinal sample is followed into institutions so that the institutional respondents are also included in the current data. Overall, the HRS is representative of the U.S. non-institutional population ages 50 years and older and their spouses. This study makes use of seven observation waves (1998, 2000, 2002, 2004, 2006, 2008, and 2010) to identify changes in physical health status across waves and mortality incidence for the U.S. population. The analytical sample is age 65 and over in this study in order to make comparisons with the data for Japan. The birth years of the analytical sample range from the turn of the 20th century to the 1940s, which is a period during which the U.S. experienced steady economic growth, demographic transition, and epidemiologic transition.

This study uses the full sample (including the refreshed sample) to get the complete mortality and health data in each survey data set. The data from NUJLSOA is from 1999 to 2009. The data from HRS is from 1998 to 2010. Two data have similar year range and the middle point of 2004.
**Health measures**

**Death**

HRS linked to a registry system that provides data pertaining to the death of individuals who died since the time of the interview, but NUJLSOA did not. Since the two data sets are longitudinal surveys, death information is obtained during the follow-up interviews. For example, dates of death in NUJLSOA were obtained from family members for those who died after the day of their initial interview until 2009 (Yong and Saito 2012). In HRS, deaths were identified via the Tracker file and/or the National Death Index.

**Disability - ADLs**

Disability is conceptually different from functional limitation which refers to personal capability. Disability is a gap between personal capability and environmental demands. Disability can be mitigated at either side, by increasing capability or by reducing demand. Therefore disability is the “outcome” of functional limitations and environmental demands in the disablement process and refers to whether a person can live independently or provide self care (Verbrugge and Jette 1994). People with the same level of personal capability can have different levels of disability if they live in social conditions with different demands. Therefore, differences in environmental demands would produce differences in the disability even if the countries’ populations had the same level of functional problems.

Disability was measured by difficulties with activities of daily living (ADLs) in this study and ADLs are necessary for survival (Verbrugge and Jette 1994). One composite measures for ADLs were created in this study. The ADLs measure included six items: dressing, bathing,
eating, bedding, walking and toileting. An individual was considered as having an ADL disability if he/she had difficulties in performing at least one of the six ADL activities.

**Functional limitation**

Functional limitations are restrictions in an individual's physiological ability to perform fundamental physical actions in daily life. They indicate overall abilities of the body to do purposeful work, such as stooping, lifting, and climbing, and they are less sensitive to social roles and environmental demands (Freedman and Martin 1998; Verbrugge and Jette 1994). Therefore, a cross-national comparison of population health using functional limitation as the metric can bring us closer to understanding the difference in the physical capacity of older people from Japan and the United States.

Functional limitation was measured by difficulty in performing at least one of six NAGI items (Nagi 1965), which is defined as unhealthy in this study. The six items are the maximum common functional limitation measures that can be obtained across two data sets. The questions on physical functioning in the two surveys were designed to be similar as well. The wording from each survey may have been slightly different, but the meanings for each NAGI are the same. The six NAGI items are sitting for about two hours; climbing one flight of stairs without resting; stooping, kneeling, or crouching; reaching or extending your arms above shoulder level; lifting or carrying weights over 10 pounds, like a heavy bag of groceries; picking up a dime from a table.

**Ailments (chronic conditions)**

A pathological condition is often the origin of the disablement process that results in disability (Minaire 1992; Verbrugge and Jette 1994). The disablement process is one of
progressive changes through which disease and injury can potentially lead to functional limitations and then to disability (Freedman et al. 2002; Verbrugge and Jette 1994). Therefore, different chronic conditions can impact the disablement process in different ways due to their effects on functional limitations and disability (Femia et al. 2001). Some fatal conditions (e.g., cancer, heart diseases) are becoming leading causes of death at older ages in the long-lived populations in Japan and the United States. When life expectancies of two populations have steadily increased over the past years, well-being of older individuals has become a growing concern. The day-to-day problems (e.g., treatment and disease management) confronting individuals after a medical diagnosis have drawn more and more attention from institutions and policy-makers (Minaire 1992).

Self-reported ailments (chronic conditions) investigated in this study included diabetes, heart disease, stroke, cancer, and chronic lung disease. In the HRS, chronic conditions were determined on the basis of self-reports of whether a doctor had ever told the respondent that he/she had any one of the health conditions above. In the NUJLSOA, the question was worded as “have you ever had or ever experienced the condition?” (Reynolds et al. 2008). This article used a summary measure to record whether people had ever had at least one of these ailments, which was defined as “unhealthy” in this study.

Education

Education at the time of the interview was reported as years of formal schooling and as levels of educational attainment for respondents (e.g., no education, primary school, junior high school, etc.). However, recoding the education of the elderly in Japan and the United States into the same categories is almost impossible due to much different education distributions.
Accordingly, the education levels of the respondents are recoded into three broad categories of low, middle, and high levels of schooling.

In the NUJLSOA survey, education was reported with the use of seven categories in the first wave in 1999 and by single years in the second wave in 2001. In the first wave, the lowest education level available was junior high school, and the majority of older Japanese people in the data file belonged to this group. Cutler and Lleras-Muney (2010) provide an evidence of a clear difference in disability between high school graduates and high school dropouts, they also find that over half of the difference can be explained by occupations, health behaviors, and chronic conditions. Therefore, people who drop out before completing senior high school could have worse employment opportunities, less income, and worse health. Therefore, this study places older Japanese who completed senior high school into the “high” level of education group and older Japanese who withdrew before completing senior high school into the “middle” level of education group. In the NUJLSOA data, the low category is junior high school and below (0–9 years), the middle category is senior high school withdrawal before completion of high school (10–11 years), and the high category is senior high school completion and above (12+ years). To compile information about year of education, this study followed the method that Reynolds et al. (2008) used: the median value of the years of education for the respondents in the Wave 1 category was assigned to those who did not answer the Wave 2 question.

In the HRS survey, the respondents were asked to indicate the total number of years of formal education completed. In the HRS survey data file, this study distinguishes older Americans’ educational attainment into the categories of 0–11 years, 12 years, and 13+ years, and this is consistent with the best-fitting form identified by Montez et al. (2012). These
education categories roughly correspond to less than a high school education (low), high school graduation (middle), and some college education and above (high) (Brown et al. 2012).

This study used two forms of education variables in order to compare and understand the effect of education on mortality. One was years of formal schooling and the other was categorical version of educational attainment. Schooling provides skills, abilities and knowledge which shape health and well-being. The more years of schooling, the greater human capital obtained, and the better health achieved (Ross and Mirowsky 1999). This study used years of formal schooling to identify whether a positive association between quantity aspect of education and different health measures exists in Japan and the United States. However, the non-linear association between education and health cannot be investigated by using years of education. Therefore, the categorical version of education attainment was adopted here to examine the possible non-linear association between education and health in the two populations. The other advantage of using a categorical measure of education is that we can investigate the educational gradient of health expectancy in two countries.

**All-cause mortality rates**

To estimate mortality rates, we reformatted the data into person-year files and estimated a set of country-gender specific hazard models that regressed the log of the risk of death on age. The country-gender specific models were estimated and the models are as follows:

\[
\ln m(t, Edu) = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot Edu\_year
\]
\[
\ln m(t, Edu) = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot Edu\_Middle + \beta_3 \cdot Edu\_High
\]

where, \( t \) is age expressed in single years, and

\[
m(t, Edu) = \lim_{\Delta t \to 0} \frac{\Pr (t \leq T \leq t + \Delta t | T \geq t, Edu)}{\Delta t}
\]

\(^1\) (Kleinbaum and Klein 2005)
The parameter estimates from the hazard models were used to solve the regression equations and calculate predicted age-specific mortality rates by education, sex, and country (Teachman and Hayward 1993). The rates are analogous to exponentially smoothed occurrence-exposure rates (Brown et al. 2012). This study uses two forms of education variables in order to compare and understand the effect of education on mortality.

**Prevalence probability**

A set of nation-gender specific logistic regressions of the following form stratified by nation and gender were fitted to get an estimation of prevalence probability.

\[
\ln \left( \frac{\pi}{1 - \pi} \right) = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot Edu\_year
\]

(4) \hspace{1cm} \ln \left( \frac{\pi}{1 - \pi} \right) = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot Edu\_Middle + \beta_3 \cdot Edu\_High

(5)

where \( t \) is age expressed in single years, and \( \pi \) is defined as the probability of unhealthy state which is defined as (a) having disability, (b) having functional limitation, or (c) having ailments separately for each physical health situation.

This study used two forms of education variables in order to compare and understand the effect of education on health prevalence. One is years of formal schooling and the other is a categorical version of educational attainment. The reasons are the same as described above for the estimation of mortality.

**Prevalence-based life tables – Sullivan’s method.**

To calculate life expectancy and determine the number of years life lived in the healthy health, this study used the so-called the “Sullivan” method (Sullivan 1971), which is a prevalence-based method of estimating healthy life expectancy. This method divides total life expectancy into the different health states based on the age-specific prevalence of
This method reflects the current health structure of a real population adjusted for age and mortality levels (Yong and Saito 2009).

This study used a prevalence-based method instead of incidence-based method to estimate life expectancies within and without healthy states. It is known that incidence rates are more sensitive to sparse data than prevalence rates, and produce highly unreliable estimates of transition rates. An inspection of the two longitudinal data files shows that sparse data for a number of the transitions in the two countries is clearly problematic. Thus, in order to compare expectancies across the two countries, this study relied on prevalence rates – which are more stable and reliable - to measure health conditions in the two populations. The prevalence-based life tables in this study were calculated from Sullivan’s method by incorporating both age-specific mortality rates estimated from equation (2), and age-specific prevalence probability (proportions) estimated from equation (5) above. The detailed formulae are below:

\[
p_x \approx 1 - \frac{m_x}{1 + 0.5 \cdot m_x}
\]  
(6)

\[
l_{x+1} = l_x \cdot p_x
\]  
(7)

\[
d_x = l_x - l_{x+1}
\]  
(8)

\[
L_{x+1} = l_{x+1} + 0.5 \cdot d_x
\]  
(9)

\[
L_{100} = \frac{l_{100}}{m_{100}}
\]  
(10)

\[
\text{Person years lived at ages from age } x:
\]  
(11)
\[ T_x = \sum_{a=x}^{100} (L_a) \]

Life expectancy at age \( x \):
\[ e_x = \frac{T_x}{l_x} \]  

(12)

Person years lived with healthy state:
\[ L^H_x = (1 - \pi) \cdot L_x \]  

(13)

Total years lived with healthy state from age \( x \):
\[ T^H_x = \sum_{a=x}^{100} (L^H_a) \]  

(14)

Life expectancy within healthy state:
\[ e^H_x = \frac{T^H_x}{l_x} \]  

(15)

The mortality rate \( m_x \) can be estimated from equation (2) and then \( p_x \) can be calculated from equation (6). The assumption of equation (6) is that the deaths happen uniformly in the interval between age \( x \) and \( x+1 \). Using equation (7) to calculate the survivor function, \( l(x) \), the life table decrement function is obtained from equation (8). Then, person-years lived between ages \( x \) and \( x+1 \) is calculated from equations (9) and (10). Person-years lived at ages older than \( x \) is the accumulation of person years at each age interval starting from age \( x \) in equation (11). The life expectancy at age \( x \) is the ratio of accumulation of person-years above age \( x \) and the number of survivors at age \( x \), from (12). Person-years lived with healthy condition can be computed in equation (13) via \( \pi \) estimated in logistic regression in (5). After summing up person years within healthy condition by equation (14), the healthy life expectancy can be done with equation (15) and life expectancy within unhealthy condition is one minus the healthy life expectancy (Jagger et al. 2006).
A bootstrapping technique is used here to obtain standard errors for the life table functions. Bootstrapping generates repeated calculations of the life table functions by randomly drawing a series of bootstrap samples from the analytic samples. The bootstrap method is a data resampling method which is used to derive variance estimates when analytic methods are unavailable (Efron 1987; Efron and Tibshirani 1986). The bootstrap method used here has been implemented in recent demographic studies (Cai et al. 2010; Cai and Lubitz 2007). It considers the sampling design elements such as stratification and multi-stage clustering in large-scale and complex surveys, such as the two surveys in the study. Suppose that there are certain amount of strata in the survey and there are \( n_i \) PSUs in stratum \( i \). The bootstrap method draws samples from \( n_i - 1 \) PSUs with replacement within stratum \( i \). The original sampling weight \( w_j \) for each PSU \( j \) drawn within stratum \( i \) will be re-calculated as \( \frac{n_i}{n_i-1} \cdot m_j \cdot w_j \), where \( m_j \) is the number of times the PSU \( j \) is sampled. Then, mortality rates, prevalence probability and prevalence-based life tables are estimated based the bootstrap sample. We repeat this approach 300 times, thereby obtaining the distributions of the life table functions and estimate sampling variability for the life table functions. The standard deviations of the distributions of the life table functions are the standard errors used in the calculation of 95% confidence intervals. This study combined this information with the original estimates to construct confidence intervals and conduct significance tests across the education, sex, and country groups.
Preliminary Results

Our preliminary results show that education coefficients are similar for both Japan and USA populations. However, older Japanese have superior mortality and health profiles. Older Japanese in the lowest education group have similar (better) TLE to older Americans in the highest education group. Older Japanese in the lowest education group even have better HLE, ULE, % (HLE/TLE) profiles than those of older Americans in terms of ADL, functional limitation and major chronic conditions.

Table 1. Regression results: the Education coefficients

<table>
<thead>
<tr>
<th>Sex</th>
<th>Education</th>
<th>Mortality</th>
<th>ADL</th>
<th>FL</th>
<th>Morbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Japan USA</td>
<td>Japan USA</td>
<td>Japan USA</td>
<td>Japan USA</td>
</tr>
<tr>
<td>Male</td>
<td>Years</td>
<td>-0.04* -0.04*</td>
<td>-0.09* -0.09*</td>
<td>-0.06* -0.08*</td>
<td>0.01 -0.01*</td>
</tr>
<tr>
<td></td>
<td>(ref=Low)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>-0.03 -0.16*</td>
<td>0.13 -0.05*</td>
<td>0.09 0.01</td>
<td>-0.08 0.03</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>-0.48* -0.40*</td>
<td>-0.38* -0.31*</td>
<td>-0.26* -0.33*</td>
<td>0.10* -0.09*</td>
</tr>
<tr>
<td>Female</td>
<td>Years</td>
<td>-0.01 -0.04*</td>
<td>-0.09* -0.09*</td>
<td>-0.07* -0.09*</td>
<td>0.01 -0.05*</td>
</tr>
<tr>
<td></td>
<td>(ref=Low)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>-0.17 -0.23*</td>
<td>-0.12* -0.11*</td>
<td>0.03 -0.05*</td>
<td>-0.01 -0.05*</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>-0.44* -0.36*</td>
<td>-0.17* -0.30*</td>
<td>-0.22* -0.30*</td>
<td>0.01 -0.19*</td>
</tr>
</tbody>
</table>

Note: intercept and age terms not shown here
Table 1. Healthy life expectancies at age 65 for Japan and the United States by sex.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Educ</th>
<th>TLE</th>
<th>ADL HLE</th>
<th>ULE</th>
<th>% (hle/tle)</th>
<th>FL HLE</th>
<th>ULE</th>
<th>% (hle/tle)</th>
<th>Ailments HLE</th>
<th>ULE</th>
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