Zachary Zimmer and Hui-Sheng Lin

Changes in Prevalence and Transition Rates of Functioning Difficulties, and Limitation Severity, Among Older Adults in Taiwan: 1989 to 1996

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Organizations collaborating in this research include: Population Studies and Training Center, Brown University; Population Institute, University of the Philippines; Department of Social Work and Psychology, National University of Singapore; Taiwan Provincial Institute of Family Planning; and Institute of Population Studies, Chulalongkorn University. For additional information about the comparative project, please contact the Principal Investigator: Albert I. Hermalin, Population Studies Center, University of Michigan, PO Box 1248, Ann Arbor MI 48106-1248 USA.

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Population Studies Center, University of Michigan
PO Box 1248, Ann Arbor, MI 48106-1248 USA

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Zachary Zimmer, Research Associate, The Population Council

Hui-Sheng Lin, Taiwan Provincial Institute of Family Planning

ABSTRACT

This paper examines changes in functional health among older Taiwanese between 1989 and 1996. Some contrasts are made to the improvements in functional health that have been witnessed in the United States over a similar time period. Measures of functioning include difficulties lifting, climbing stairs, and walking a given distance. Both existence of and severity of functional difficulties are investigated. Prevalence rates are examined in order to determine whether there have been improvements in the reporting of functional difficulty on a population-wide level, while transition models, which include mortality, are constructed in order to determine whether a smaller proportion of the older population in Taiwan moved into states of disability, and whether a larger proportion improved status, during the latter part of the study period. Prevalence and transition rates are adjusted for compositional variables, and in the case of transitions, for inter-survey intervals. The analyses suggest several phenomenon have been taking place simultaneously in Taiwan. There have been reductions in mortality, increases in the probability of an onset of functional difficulty and improvements in rates of recovery for those who have functional difficulties. Although these represent mixed findings, it might be interpreted in a positive light for a society that has only recently moved its economy and mortality rates to Western equivalence.

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DATA SETS USED: Survey of Health and Living Status of the Elderly in Taiwan, 1989, 1993 and 1996.

KEY WORDS: Aging, Asia, Taiwan, Functional status, Health

INTRODUCTION

Demographers have long recognized that *population aging*, a growth in the number and proportion of older persons within a population, is occurring in many parts of the world and poses a number of challenges. Older adults, for instance, are more likely to utilize health services and require instrumental assistance with functional tasks than are younger persons. As such, determining the prevalence and incidence of functional disability becomes vital for forecasting the long-term needs of societies characterized by population aging.

Nowhere in the world is population aging occurring as rapidly as in some societies in Asia (Martin, 1988). In the near future, it will be a number of Asian nations that will have the oldest age structures in the world (Rowland, 1994) and will subsequently be faced with a multitude of health care challenges (Hermalin, 1995). Taiwan is a typical example of such a society. The proportion of those aged 60 and older is about 11% today in Taiwan, but this number is expected to more than double over the next couple of decades as the sharp declines in fertility that have recently been experienced begin to transform the age structure of the society. Moreover, the large families that exist in today's Taiwan, which provide older aged adults with a number of children to rely upon for their support needs, will soon be replaced by much smaller families.

As the number and proportion of older adults in Taiwan and other such rapidly aging societies grows, there becomes an increasing need for studies that examine health and changes in health among this population. The current study employs a longitudinal data set to determine how functional status among older Taiwanese has changed in recent years. Studies of this nature in non-Western societies are lacking, but studies that have been conducted in the United States can provide some basis from which to compare functional changes among older populations that might be occurring elsewhere. Evidence from the 1970's and early 1980's indicated that the gains in life expectancy that were realized during this period was accompanied by an increasing prevalence of disability (Colvez and Blanchet, 1981), suggesting a trade-off between longer life and worsening health (Verbrugge, 1984). Using a multi-state life table approach, Crimmins, Hayward and Saito (1994) demonstrated an increase in the proportion of life spent in dependent states of health is a natural outcome of improving mortality. Conversely, Waidmann, Bound and Schoenbaum (1995) questioned the validity of disability reports amidst a changing health environment, suggesting that the increase in disability rates were a function of better diagnostic techniques and earlier detection of chronic disease.

More recently, however, some consistent evidence has appeared supporting the notion that declines in rates of functional disability among older American adults have been achieved in the 1980's and 1990's. Manton, Corder and Stallard (1993), employing the National Long Term Care Surveys (NLTCS) showed decreases in both prevalence and incidence of disability between 1982 and 1989. Crimmins, Saito and Reynolds (1997), using both the National Health Interview Survey (NHIS) and the Longitudinal Study on Aging (LSOA), Ofstedal, Madans and Feldman (1994) using the LSOA, and Manton, Corder and Stallard (1997) using the NLTCS, all confirmed these trends continuing into the early 1990's. Freedman and Martin (1998) employed the Survey of Income and Program Participation (SIPP) and demonstrated that declining unadjusted and adjusted prevalence rates of functional limitations among elders was strongest for the oldest-old. This latter study is perhaps most enlightening for our current purposes since, rather than basing their assessment on the typical assortment of Activities of Daily Living

(ADLs) and Instrumental Activities of Daily Living (IADLs), such as ability shopping or managing money, they used items that questioned the ability to conduct certain physical movements such as lifting and climbing. These functional tasks are less predisposed to role expectations and environmental circumstance and therefore can be more easily compared across cultures (Freedman and Martin, 1998).

The current investigation utilizes these U.S. based studies as a guide in order to determine whether Taiwanese elders have experienced similar improvements in functional status between the years 1989 and 1996. One important fact that has been established by others is that there is a fair degree of fluctuation in and out states of disability such that individuals can experience both declines and improvements in functional capacity over short periods of time (Anderson, James, Miller, Worley and Longino, 1998; Crimmins and Saito, 1993; Manton, 1988). These studies have demonstrated the need to account for a variety of transitions when estimating changes to physical functioning of older populations. Given the potential for both improving and worsening health, and the possibility of trade-offs between mortality and morbidity, we focus on both changes in prevalence and changes in transitions in and out of states of disability, while in the latter instance, we include mortality as a possible transition.

The time period 1989 to 1996 provides for an interesting examination since it was a period that witnessed a number of changes to the social structure of Taiwan that could influence older adult health. The proportion of the population who was elderly increased during this time period by several percentage points. A growing elderly population was, however, accompanied by a rapidly developing economic infrastructure that may have provided them with greater opportunities for health care and better access to health-related information. There was tremendous economic development occurring in Taiwan during this period, with a rapidly increasing Gross National Product. Perhaps more importantly, in 1995 Taiwan instituted a Universal Health Insurance (UHI) program (Taiwan Department of Health, 1999) providing health insurance coverage for the entire population for preventive services and most inpatient, outpatient, and in-home medical care. The introduction of this plan resulted in a rapid and dramatic increase in utilization of both outpatient and inpatient care in Taiwan (Chiang, 1997). Concurrently, Taiwan experienced increases in life expectancy.

DATA

Data for this study come from three waves of the “Survey of Health and Living Status of the Elderly in Taiwan,” a project jointly conducted by the Taiwan Provincial Institute of Family Planning in Taichung, Taiwan, and the Population Studies Center at the University of Michigan, and funded by the U.S. National Institute on Aging. Respondents of the age 60 and older were first interviewed between April and June of 1989. The first follow-up was conducted during the same time of year in 1993, with a third follow-up conducted in 1996. This means that those initially interviewed in 1989 were at least 67 years of age by 1996. In this study, in order to present results that are comparable to those reported in the U.S., we limit our analysis to individuals aged 65 and older. The 1996 survey included an ‘add-on’ component where individuals aged 50 to 66 were interviewed for the first time using a similar questionnaire as those 67 and older who would have been completing their third wave of the survey. This add-on allows us to construct a cross-sectional sample from each of the three surveys that are aged 65 and older.

The initial 1989 survey consisted of a nationally representative sample of 4,049 respondents, of which 61.4% were 65 and older. National representation meant that not only was

the noninstitutionalized older population included in the random selection of respondents, but a special effort was made to include institutionalized individuals and, through the use of proxy respondents, individuals who were incapable of answering the questions. The response rate for the first wave was 92%. Deaths up to the time of follow-up were recorded, and the surviving individuals represent the sample for subsequent surveys. In this fashion, the follow-up surveys are also nationally representative of an older population. Of the initial respondents, 588 died prior to the 1993 follow-up, 307 were refusals or their status was unknown, and 3,154 completed the follow-up, of which by this time 94.8% were 65 and older. The response rate for the follow-up was then 91%. The 1996 follow-up attempted to reinterview all respondents from the earliest survey. 2,669 of these individuals were interviewed. An additional 459 individuals had died between 1993 and 1996, and the response rate was 89%. The add-on survey in 1996 included 256 individuals aged 65 to 66, making the sample size of those 65 and older in 1996 2,925. The second panel of respondents added in 1996 were selected in a fashion that, when combined with the initial sample, creates a representative sample of those aged 50 and older.

Taiwan maintains a Household Register of each resident, and this register was used to select a random sample. Three stratified sampling stages were employed. First, a number of 'townships' or administrative units were selected from the 361 administrative units in Taiwan. Second, a selection of 'blocks' or *lins* was chosen within townships. Third, two eligible individuals within each block were randomly selected to be interviewed. The stratified sample was conducted proportionate to size, and the final sampling ratio was 1/370. Further information on the sampling procedure and the other methods used in the data collection can be found in *1989 Survey of Health and Living Status of the Elderly in Taiwan: Questionnaire and Survey Design* (1989).

MEASURES OF PHYSICAL FUNCTIONING

The three waves of the survey all contain detailed health and demographic information. A series of physical functioning items, asking respondents whether they have difficulty carrying out a number of tasks, on their own, without assistance from an individual or a device, were repeated with identical wording throughout. If difficulty was reported, respondents were asked about the severity of the difficulty, resulting in a four category response for each item (can do the task without difficulty, has a little difficulty, has a lot of difficulty, cannot do the task at all).

Functional task items on the survey included Activities of Daily Living (Katz, Ford, Moskowitz, Jackson and Jaffe, 1963), which are those tasks necessary for personal care, and Instrumental Activities of Daily Living (Lawton and Brody, 1969), which are those tasks necessary to maintain a living environment. An assessment of the ability to conduct many of these types of tasks depends upon socially defined roles and environmental circumstances. For instance, a response to a question that asks about the ability to shop for things can depend upon whose role it is to do the shopping or the availability of transportation to and from shopping areas. Cross-cultural comparisons of these types of items might then be influenced by variations in expectation or environmental barriers (Freedman and Martin, 1998; Verbrugge and Jette, 1994). There are, however, a number of tasks, identified by Nagi (1976), that require the ability to perform basic physical actions that are less tied to socially defined roles. We adopt three of these functional tasks, lifting, climbing stairs and walking, for the current study. The selection of these three items allows some comparability with Freedman and Martin's (1998) recent examination of American elders.

We use the three functional tasks to create three different physical functioning outcome variables. First, we create a measure of the ability to conduct all three tasks by coding individuals as a 1 if they report difficulty with at least one of the three tasks and 0 if not. Second, we create measures for the ability to conduct individual functional tasks by coding each of the three as 1 if the individual reports any difficulty with the task and 0 if not. Third, we take advantage of the four-category scale for each item to create an ordinal measure for functional limitation severity among those who report at least one difficulty. Individuals are coded as having mild limitations if they report only a little difficulty with only one of the tasks, but they can do the other two without any difficulty. A coding of moderate limitations is given to those who have a little difficulty with more than one task, or more than a little difficulty with one or more task, but they can at least do one of the three to some degree, even if it is with a lot of difficulty. Finally, a coding of severe limitations is given to those who report that they absolutely cannot do any of the three tasks.

In order to adjust prevalence and transition rates for the composition of the population, we consider a number of covariates in multivariate models. These include age, measured continuously, sex (1 for female, 0 for male), marital status (1 for married, 0 for other), rural/urban residence (1 for rural, 0 for urban), ethnicity (1 for Mainlander, 0 for other) and education. Education is measured as a three-category variable. None, no more than primary, and more than primary, are the three categories, with none serving as the comparison. With respect to ethnicity, Taiwan is a fairly homogenous population ethnically. However, there is a group of individuals who arrived in Taiwan after the cultural revolution in China who were mostly male soldiers. These individuals evacuated the communist regime and followed Chiang Kei-shek. They tended to take up jobs in the government and as a result have had better health insurance than the majority of the Taiwanese population. Because they tended to be soldiers, they may be more physically fit in older age than are others. They also tended to marry less often. Because this is a select group, their health related behaviors and their functional status tend to differ from the rest of the elderly population, and it is worth considering them as a separate ethnic group.

ESTIMATING CHANGES IN PREVALENCE AND TRANSITION RATES

i. Prevalence

Prevalence is defined as the proportion of the population reporting specific difficulties, at least one difficulty, or a limitation severity. In order to determine whether there were significant changes in prevalence over the three time periods, we pooled cross-sectional samples for 1989, 1993 and 1996. We fitted logistic models for specific difficulties, and having at least one of the three difficulties, that included dummy variables for year of survey, using 1989 as the comparison category, and the compositional variables. These regressions take the form of:

$$\ln (P/1-P) = \alpha_0 + \alpha_1 \text{ Year } 1993 + \alpha_2 \text{ Year } 1996 + \alpha_3 x_3 \ldots \alpha_9 x_{9,}$$

where $\alpha_3 x_3 \ldots \alpha_9 x_9$ represent the seven compositional variables. For these, sex, ethnicity and the two education variables are assumed to not vary over time and come from the 1989 data. For age, marital status and residence, appropriate time-varying values from the individual surveys are entered.

We also fitted multinomial models to determine the influence of year on the prevalence of functional task limitation severity (that is, mild, moderate or severe) for those who report at least one difficulty. The multinomial takes the form of:

$$\ln (P(Y=j)/P(Y=J)) = \beta_0 + \beta_{j1} \text{ Year 1993} + \beta_{j2} \text{ Year 1996} + \beta_{j3}x_3 \ldots \beta_{j9}x_9,$$

where j can represent the categories of moderate or severe limitation and J represents mild limitations, which serves as the baseline category. The natural log odds of being in one of the other two severity states (moderate, severe) relative to having mild limitations is estimated simultaneously.

In order to provide a more intuitive interpretation of the changes in prevalence, adjusted probabilities are calculated based on the results of the equations listed above (Roncek, 1991). To do this, we calculate each individual's inherent probability of being in any category using the coefficients derived in the equations and the values of the compositional variables applicable to an individual, but we hold the years constant at 1989, 1993 or 1996. Thus, for each year, each individual will be characterized by a set of probabilities that will sum to 1.0. The mean of these probabilities across the sample represents the adjusted prevalence.

ii. Transitions

To examine changes in transition probabilities, we identify two time periods. T1 is the 1989 to 1993 time period and T2 is the 1993 to 1996 time period. Each of these time periods will be characterized by certain transition rates from an originating state at the start of the period (1989 or 1993) to an end of period state (1993 or 1996). For instance, we can determine the transition rate from not having any difficulties to having at least one difficulty and compare this rate in T1 with T2. If functional status is improving then we would expect T2 minus T1 to be negative, that is, the rate of moving into a state of functional difficulty from a state of no functional difficulty is lower in T2 than in T1.

To estimate the transitions, we pool two sets of data, the first representing T1, and the second representing T2. Compositional variables for these sets of data are measured from the originating time period. We fit multinomial equations that estimate the relative risks of ending up in particular states. We consider separate models for each originating state, and define a number of possible outcomes that include the possible originating states plus death. For instance, an individual originating without difficulties can be categorized as having no difficulties, having at least one difficulty, or having died as their end state. The multinomial equation that is estimated has the following form:

$$\ln (P(Y=j)/P(Y=J)) = \beta_0 + \beta_{j1} \text{ T2} + \beta_{j2}x_2 \ldots \beta_{j8}x_8,$$

such that T2 is included in the model and T1 is defined as the comparison category. Our models therefore compare the transition probability during the later time period (1993 to 1996) with the earlier time period (1989 to 1993). When estimating the risk of having any one of the three difficulties, or any specific difficulty, J is defined as the risk of not having the difficulty, while j can take on the states of having the difficulty or death. When estimating the risk of limitation severity, we define j as the risk of improving, getting worse, or dying, and J as the risk of remaining in the state of origin, and we estimate the risk of a various changes in state relative to the risk of remaining in the state of origin simultaneously.

After estimating these equations, we determine the adjusted transition probabilities by using our equation coefficients in a similar fashion as was described above. Unfortunately, we have a problem in that our periods T1 and T2 represent different lengths of time, T1 being a four-year transition period, T2 being a three-year transition period. This means that these calculated adjusted transition rates cannot be directly compared. That is, there would be a magnitude bias in the risk of moving out of a state of origin due to different lengths of exposure. To estimate comparable transition rates, we follow the technique described by Manton, Corder and Stallard (1993) for adjusting for inter-survey interval length and mortality, although unlike these authors, we estimate one-year adjusted transition rates rather than adjusting our three-year rates up to four-years or our four-year rates down to three-years. We assume that an individual who moves out of a state of origin makes only one transition during the period, an individual who ends in the state of origin has made no transitions, and that rates of movement into a different state are consistent across time. The one-year rate for the three-year period is the three-year probability raised to a power of 1/3, while the four-year probability is raised to a power of 1/4 such that:

$$ {}_1P_{T1} = P^{1/4}{}_{T1} \quad \text{and} \quad {}_1P_{T2} = P^{1/3}{}_{T2} $$

The result is the expected probability of remaining in the state of origin after one-year given consistent rates of movement across time.

To determine one-year probabilities for other end states, we assume that changes in the probability of staying in a state are exactly balanced off by changes in the probability of moving to other states, and rates of movement to other states are consistent across time. As such, one minus the one-year probability rate of remaining in the state of origin is the one-year probability of moving to another state, and this probability is distributed across the other states accordingly. The end result is a matrix with originating states and end states as the columns and rows, whereby the sum of the transition probabilities across the rows add to 1.0. Our results are interpreted as the probability that an individual who began in a given state (say without any difficulties) will remain in that state or move to another state (say with at least one difficulty or death) after a one-year period of time, and we compare these between our two originating years, 1989 and 1993. Finally, to compare physical functioning transitions regardless of mortality, we determine the rates adjusted for mortality by renorming the transition probabilities for the proportion of deaths that occur over the one-year interval (Manton, Corder and Stallard, 1993).

RESULTS

i. Changes in the prevalence of functional difficulties and limitation severity

Table 1 shows the unadjusted rates of functional difficulty among older adults in Taiwan in 1989, 1993 and 1996, and also presents a comparison to those reported by Freedman and Martin (1998) for similarly aged U.S. elders in 1993. Looking at the upper panel of the table, older Taiwanese report the greatest difficulties lifting things and the least difficulty walking. There has been some decline in the percent reporting difficulties after 1989, but the majority of the decline appears to have taken place between 1989 and 1993 with a leveling of rates to 1996. Looking at the percent reporting at least one difficulty provides a good example. The percent dropped from 47.4 to 44.4 between 1989 and 1993, and then leveled off to 44.6 in 1996. This pattern is similar for difficulty walking. There has been a more consistent decline in the percent

reporting difficulties lifting, but the change is not significant, while the percent reporting difficulties climbing stairs declined substantially from 1989 to 1993 then increased in 1996 to slightly below the percent reporting difficulties in 1989.

The rates for the U.S. allow for some comparison, although variation in the way questions were asked limits our ability to make any firm judgements about differences in functional abilities across societies. For instance, only 26.6% of elderly Americans reported difficulty lifting in 1993 compared to over 39% of elderly Taiwanese, but the U.S. survey asked about ability lifting 10 lbs. compared to 25 lbs. in Taiwan. It is interesting, however, that the Taiwanese were less likely to report difficulties climbing stairs, despite that the Taiwanese question asked about 2 to 3 flights instead of 1 flight in the U.S., and were less likely to report difficulties walking, despite a similar distance being the reference in both surveys. These results may suggest better fitness among older Taiwanese than among older Americans.

The bottom panel of Table 1 lists unadjusted rates for functional limitation severity, among those reporting at least one difficulty, across the three survey years. Of those who report at least one difficulty, the distribution of severity did not change much. If anything, older adults in Taiwan who did have functional disorders were more likely to report them as severe in 1996 than in previous years.

Besides changes to the percent reporting functional difficulties between 1989 and 1996, the composition of the population changed as well, and it may be that the rates of decline would have been more dramatic given similar population compositions. Table 2 shows how the composition of older Taiwanese changed over the three survey years. All of these changes, except for sex and ethnicity, are significant to a .05 level. For instance, the percent of the older population aged 80 and older increased from 9.8% in 1989 to 11.8% in 1993 and further to 14.5% in 1996. The mean age of older Taiwanese increased from 71.6 in 1989 to 73.0 in 1996. Hence, the age distribution of the older population in Taiwan between 1989 and 1996 was becoming more weighted towards the oldest-old. Since older individuals are more likely to report functional limitations, one of the reasons for the leveling of prevalence rates between 1993 and 1996 could be the further aging of the population. On the other hand, the data show that older Taiwanese were more likely to be married in 1996 than previously, and more likely to have higher levels of education, two factors commonly thought to promote better functional status.

Given these changes to the population, it is necessary to control for compositional variables in order to determine whether there has been a real change in functional abilities of older Taiwanese. Table 3 shows the results of pooled data logistic regression equations for each specific functional difficulty and for limitation severity among those who do report difficulties. Negative coefficients for year indicate a decline in the probability of specific difficulties being reported and, given that the limitation severity models contrast moderate or severe with mild limitations, a decline in the probability of reporting more serious limitations relative to mild. Reductions in –2Log-Likelihood when adding the year variables to equations, reported at the bottom of the table, determine whether there have been significant changes over time.

Looking at the first equation, it is apparent that there was a steady and significant decline in the log odds of reporting at least one difficulty between 1989 and 1996, when controlling for compositional variables. By taking the exponent of coefficients for this equation (not shown in table) we find that in 1993, older adults in Taiwan were only about 86% as likely to report at least one difficulty in comparison to 1989, while in 1996 they were only 80% as likely. Looking across the functional tasks, there were also declines in the log odds of reporting specific difficulties after 1989, but not necessarily between 1993 and 1996. Consistent declines

throughout the survey years are found for difficulty lifting. For difficulty climbing stairs and walking, the declines were greater between 1989 and 1993 than between 1989 and 1996. With respect to the severity of limitations for those reporting any difficulties, there was some decline in the log odds of reporting moderate limitations relative to mild, which would be seen as a favorable change, but the other coefficients for year do not near significance.

Coefficients for the compositional variables are, for the most part, in the expected directions. For instance, older age, being female, and having less education, increases the probabilities of reporting difficulties. Being married, living in rural areas, and being Mainlander, generally decrease probabilities, but there is less significance and some mixed results among these compositional variables.

Adjusted prevalence rates derived from these previous multivariate equations are seen in Table 4. Starting with the upper portion of this table, there has certainly been a decline in the prevalence of any and specific functional difficulties since 1989. For instance adjusting for age, sex, and other compositional variables, about 48% of older Taiwanese reported at least one difficulty in 1989. This was reduced to about 45% in 1993 and further to about 43% in 1996. For climbing stairs and walking, however, the declines did not continue through the latter period. For instance, about 25% of older Taiwanese reported difficulties walking in 1989. This decreased to 18% in 1993, but leveled to 20% by 1996.

Also included in this table is a comparison to U.S. data in 1993 (Freedman and Martin, 1998). These results are adjusted for a similar set of covariates. Like the unadjusted rates, the Taiwanese elders appear to have less difficulty climbing stairs and walking, but more difficulty lifting things, in comparison to the older Americans. In each instance, the difference between the 1993 U.S. and the 1993 Taiwanese rates is about ten percentage points. Although the weight referred to in the lifting question differed across surveys, the other two items suggest that Taiwanese may be more functionally able than Americans at older ages after adjusting for age, sex, and other demographic covariates.

The bottom of the table shows adjusted prevalence rates of mild, moderate, and severe limitations, across years, for those reporting at least one difficulty. Though the probability of having no limitations increased over time, there was not much change in limitation severity, and the multivariate procedure indicated that year was an insignificant predictor of these prevalence rates.

ii. Changes in transitions of functional difficulties and death

Prevalence rates, which represent the proportion of the population in a particular functional state at any one point in time, are the outcome of earlier prevalence rates and the rates of transition in and out of states of functional limitation. (We use the term transition rather than incidence since the latter normally connotes movement into a state of disorder, where we focus on movements both into and out of states of functional limitation.) For instance, a functional difficulty prevalence rate for older Taiwanese in 1996 is a function of two earlier transition rates: the transition rate into a state of functional difficulty for those originating without difficulties, and the transition rate for remaining with a difficulty for those who originated with a functional difficulty. Given constant declines in transition rates over a period of time, we would expect prevalence rates to eventually decline. Consistent transition rates over a period of time will result in consistent prevalence rates. Hence, by examining changes in transition rates in Taiwan we can get a better idea of where the older population is moving in terms of functional disorder.

We began our analysis here by running multinomial equations to predict the log odds of making specific kinds of transitions from having no difficulties with any or specific tasks at the start of a period to having no difficulties, having difficulties or dying, and from having difficulties with at least one and specific tasks to having no difficulties, having difficulties or dying. In order to make our results comparable across transition periods, we then derived predicted one-year transition probabilities using the coefficients from these equations and calculated chi-square significance values for these probabilities. Besides controlling for the originating year (1989 or 1993), these equations also adjusted for age, sex, marital status, rural/urban residence, ethnicity and education. The full models are cumbersome to present and as such we do not include them here, but they are available from the authors upon request. In Table 5 we present the adjusted one-year transition probabilities from any originating state to an end of period state, considering 1989 and 1993 originating years separately. We also present the net change in these probabilities. Probabilities are determined including death as a possible transition, and in parentheses, adjusted for mortality.

The very first row of the table shows the probability of having no difficulties, having at least one difficulty, or dying, for those who began in 1989 without any difficulties. The sum of the probabilities across the row must be 1.0. At the start of the period, all individuals represented by this row had no limitations. The denominator in this row is the number who had no difficulties in 1989 (N=1,280), and since the numerator would be the same at the start of the period, the originating probability of having no difficulties is, of course, 1.0, or 100%. After one-year, we would expect 86.1% of these individuals to remain in their originating state, while 10.5% would have at least one difficulty and an additional 3.4% would have died. Considering the 1993 originating period, the one-year transition probabilities show that 84.4% would be expected to remain without any limitations, 12.9% would have moved into a state where they had at least one difficulty, and an additional 2.7% would have died. The change in one-year rates indicates that the probability of remaining without any difficulties was .017 (or 1.7 percentage points) lower during the later period than during the earlier period, suggesting that people who began without difficulties were less likely to remain functionally unimpaired between 1993 and 1996 than between 1989 and 1993. Adjusting for mortality, we see that the probability of remaining without any difficulties declined by .023 in the later period, and this is balanced off by a .023 increase in the probability of having difficulties (the two probabilities balancing off equally here since there are only two possible transitions given adjustments for mortality). For those who began without difficulties, the probability of dying decreased at the same time as the probability of contracting functional problems was increasing. The probability of dying was .007 less for each year in the second period in comparison to the first period.

A similar pattern of mortality rate declines coupled with functional difficulty increases emerges by examining transitions from originating without specific types of difficulties. Given declining death rates, but increasing rates of functional difficulty for those originating without problems, it would appear that a fair proportion of those who did not die during the latter period have been saved from death but turn up with functional disorders, supporting a ‘longer life but worsening health’ scenario for those who began without difficulties.

Interestingly, our assessment differs when we examine the bottom part of the table, that is, those originating with any or specific limitations. Death rates also declined for these individuals, and the decline appears to be even more dramatic. For instance, for those who began with at least one difficulty in 1989, we would expect that each year 9.2% would die. For those who began with at least one difficulty in 1993, we would expect only 7.0% to die each year, a net

improvement of .022. These sharp death rate declines are detected regardless of the difficulty in question. But a longer life for those originating with functional problems does not necessarily lead to continued functional disorders. For those who began with at least one difficulty and did not die, the chances that they improved to having no difficulties was greater during the later period than during the earlier period. This is also the case for those who began with difficulties lifting. For those who began with difficulties climbing stairs and walking, the changes in functioning (not including deaths) were not favorable, but the net changes here were rather small and are not statistically significant. So, the only functional changes for those who began with difficulty that are significant are favorable ones.

iii. Changes in transition probabilities of limitation severity and death

Table 6 displays unadjusted distributions for limitation severity end states by originating severity status, for the 1989 and 1993 originating years. Those starting with no difficulties are included in this table so that the total population is represented. This table demonstrates several things. First, the unadjusted probabilities of dying increase dramatically when moving to more severe originating states. In fact, the probability of dying approximately doubles for each step in the severity scale for the 1989 originating year, starting at about 10% for those who originate without limitations, and ending at about 58% for those originating with severe limitations, and increase just as dramatically for the 1993 originating year. Second, the probability of having no limitations at the end of the period declines just as dramatically. Looking at the 1989 originating year, while about 61% of those who begin without limitations have no limitations at the end of the period, only about 1% of those beginning severely limited have no limitations 4 years later. Clearly, this latter type of transition is rare and occurs only in cases where an individual was experiencing a temporary but acute condition at time of origin. Third, as has been shown among older U.S. populations (Crimmins and Saito, 1993; Manton, 1988), there does appear to be substantial movement in and out of states of functional limitation. For instance, 35% or more of those originating with mild limitations improve status, while an almost similar proportion get worse while remaining alive. The probability of improving is less for those originating with moderate and severe limitations, but it is a potential transition nonetheless.

To determine whether those in the 1993 originating period had a higher chance of favorable transitions, we define four possible types of transitions depending upon the originating and end state: improved, remained in originating state, worsened, and died. We limit this investigation to those who began with at least one difficulty. Those who began in the severe state cannot, by definition, get worse, and so these individuals are limited to three possible transitions: improved, stayed the same, or died. Multinomial equations were fitted that adjusted for age, sex, marital status, rural/urban residence, ethnicity and education, and the resultant coefficients were used to determine predicted probabilities of making specific kinds of transitions for the 1989 and 1993 originating years. Again, full models are not presented for brevity sake but are available upon request.

Table 7 presents the one-year transition probabilities derived from the multinomial equations. We once again present the probabilities adjusted for mortality in parentheses. Net changes are also listed. There is certainly good news in this table for those originating with mild and moderate limitations. Not only were the probabilities of dying lower for these individuals during the later period, but the probability of improving severity state was increased. For instance, for those originating with mild limitations in 1989, one-year later we would expect that

16.5% would have improved and therefore would have had no limitations, 61.7% would have remained with mild limitations, 13.7% would have worsened to moderate or severe limitations, and an additional 8.1% would have died. For the 1993 originating year, the percent that would have improved after one-year increased to 24.7%, a .082 increase in the probability. The percent remaining with mild limitations would be 50.6%, which represents a decline in the later period. The percent that worsened would have increased somewhat, to 18.7%, but the percent dying would have decreased to 6.0%. Although we find, for those originating with both mild and moderate limitations, that there was an increase in both the probability of improving and worsening, the probabilities of improving increased much more substantially. For instance, looking at the transition rates adjusted for mortality for those originating with moderate limitations, the increase in the probability of worsening status is negligible (.006) compared to the increase in the probability of improving (.022).

The situation is a little different for those who originated with severe limitations. Their probabilities of dying actually increased during the later period, while their probabilities of improving declined. The net changes here, however, are relatively small, and do not near significance. Therefore, we conclude that the only statistically significant changes in severity transitions between the two periods were ones that were for the most part favorable.

CONCLUSION

The United States is currently undergoing a period of population aging, and as a consequence demographers have placed increased attention on changes in the prevalence of functional disorders and physical functioning transitions among the older population. Despite the rapid aging taking place in a number of non-Western nations, of which Taiwan is an example, no equivalent dialogue has been taken up in these societies. One of the reasons for this is a lack of adequate data that traces functional transitions across multiple waves. The current study represents an attempt to begin such a dialogue utilizing the "Survey of Health and Living Status of the Elderly in Taiwan," a three-wave nationally representative study of older Taiwanese conducted in 1989, 1993 and 1996.

The U.S. experience appears to suggest that from at least the mid 1980's to the mid 1990's there was a decline in disability prevalence among older adults (Crimmins, Saito and Reynolds, 1997;Freedman and Martin, 1998; Manton, Corder and Stallard, 1997, 1993; Ofstedal, Madans and Feldman, 1994). Using difficulties lifting, climbing stairs and walking as indicators of functional disorder, we did find some equivalence in Taiwan, although our results are hardly as strong or consistent as the U.S. findings. In particular, we found very strong declines in the prevalence of functional difficulties occurring between 1989 and 1993, but some leveling off between 1993 and 1996.

Specifically, between 1989 and 1993, and again between 1993 and 1996, after accounting for composition changes, older adults were less likely to report at least one of the three difficulties and were less likely to report difficulties lifting. Difficulties climbing stairs and walking declined between 1989 and 1993 but the prevalence rates leveled off after that. Among those who did report limitations, there was very little change found with respect to severity.

We then examined whether the later period, that is 1993 to 1996, was characterized by more favorable transitions than was the earlier period, that is 1989 to 1993, by deriving comparable one-year probability transition rates. We first examined transitions separately for those who began a period with and without any difficulty or specific difficulties. We found

different results for the two groups. On balance, the changes in transition rates became more favorable in the later period for those who began with difficulties. These individuals were less likely to die, more likely to improve in status, and less likely to remain with difficulties during the later period. For those who began without difficulties, the probabilities of dying definitely declined in the later period, but the probability of remaining without the difficulty also declined, suggesting that a mix of favorable and unfavorable transitions may be occurring among older Taiwanese. Finally, we derived one-year probabilities for improving, staying the same, worsening and dying for those originating in one of three limitation severity states (mild, moderate and severe). We found no significant changes among those originating severely limited (that is, unable to do any of the three tasks), but some improvement in the transitions from the other two states, with a larger change in the probability of improving versus getting worse, and again, a sharp decline in mortality.

Curiously, it was during the latter period (1993 to 1996) that the Universal Health Insurance program was initiated in Taiwan, theoretically providing older adults with easier and more frequent access to the medical system. Health insurance programs like the one established in Taiwan tend to focus on curative rather than preventive health. As such, this program may not have had an influence on the probability of transitions from healthy states into states of functional disorder. However, the curative aspects of the health program may be part of the reason that those who did originate with functional disorders both decreased their probability of dying and increased their probability of improving.

What we end up with in regards to changes in transitions in Taiwan are several phenomenon taking place simultaneously: reductions in mortality, increases in the probability of having functional difficulties for those functionally able, and reductions in severity and increases in recovery for those who have difficulties. Since a greater number of older adults are surviving, and recovery rates are increasing, this end result, though somewhat mixed, might be interpreted as positive for a society that has only recently moved its economy and mortality rates to Western equivalence. Although changes in access to medical care and improvements in medical technology, attributed to a rapidly developing socioeconomic infrastructure and a universal health program, may have had some influence in this regard, the short time period in the current study does not allow us to make definitive conclusions. Clearly the population needs to be monitored for a longer period of time in order to determine whether we are seeing the beginning of longer term trends.

More research is also needed in order to determine whether our findings are the result of heterogeneous changes to functioning across certain characteristics of older Taiwanese. One such characteristic that would be important to examine is education. Freedman and Martin (1999) have recently demonstrated that changes in education are the most powerful predictor of changes in functional status among older Americans. Changes in education among older Taiwanese have been significant during the period examined in the current study, but the changes occurred at overall low levels of education in comparison to those in Western societies. The future will see a much more radical alteration to the education of the older population as today's middle aged Taiwanese move into retirement years.

Regardless of which direction future changes in functional status take, the gross number of Taiwanese who will be older will increase dramatically over the next couple of decades. This means that unless very dramatic improvements in functional status take place, the health care needs of this segment of the population will expand, placing a greater burden on society. Only

consistent and long-term improvements in functional status will be able to offset changes to the population age structure.

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Table 1: Unadjusted rates of specific functional difficulties and limitation severity in Taiwan among those 65 and older, across survey waves, and a comparison to 1993 U.S. rates

	1989	1993	1996	P	1993 U.S.[a]
Specific Limitation					
Has at least one difficulty	47.4	44.4	44.6	.048	
Has difficulty lifting[b]	40.3	39.3	38.3	.334	26.6
Has difficulty climbing stairs[c]	31.4	24.4	30.3	.000	31.0
Has difficulty walking[d]	25.0	18.0	20.5	.000	31.5
Limitation Severity					
Mild difficulties	26.7	29.6	25.5		
Moderate difficulties	62.9	59.0	61.9	.067	
Severe difficulties	10.4	11.4	12.6		

[a]From Freedman and Martin, 1998, Table 3.
[b]Measured as 10 lbs. in the U.S. data and 25 lbs. in the Taiwan data.
[c]Measured as 1 flight in the U.S. data and 2-3 flights in the Taiwan data.
[d]Measured as ¼ mile in the U.S. data and 200-300 meters in the Taiwan data.

Table 2: Composition of the 65 and older Taiwanese population across survey waves

	1989	1993	1996	P
Age				
- 65 to 79	90.2%	88.2%	85.5%	.000
- 80 +	9.8	11.8	14.5	
- Mean age	71.6	71.9	73.0	.000
Sex				
- Male	54.0%	56.5%	56.3%	.113
- Female	46.0	43.5	43.7	
Marital Status				
- Married	57.6%	61.2%	60.2%	.018
- Not married	42.4	38.8	39.8	
Ethnicity				
- Mainlander	20.1%	21.7%	22.6%	.062
- Other	79.9	78.3	77.4	
Education				
- None	57.8%	50.1%	46.3%	.000
- Primary	26.4	31.8	33.3	
- More than primary	15.8	18.1	20.5	
Residency				
- Rural	34.3%	36.4%	28.3%	.000
- Urban	65.7	63.6	71.7	
Sample size	2,593	2,989	2,963	

Table 3: Logistic regression equations predicting specific functional difficulties and limitation severity using data pooled across survey waves, controlling for year and other covariates

	SPECIFIC DIFFICULTIES				LIMITATION SEVERITY	
	At least one difficulty	**Has difficulty lifting**	**Has difficulty climbing stairs**	**Has difficulty walking**	**Moderate vs Mild**	**Severe vs Mild**
Year						
- 1989	---	---	---	---	---	---
- 1993	-.148*	-.049	-.402**	-.478**	-.168^	-.082
- 1996	-.221**	-.190**	-.117^	-.360**	-.012	.097
Age	.102**	.105**	.083**	.091**	.042**	.088**
Sex (1=Female)	1.051**	1.120**	.533**	.381**	.006	-.305*
Marital status (1=Married)	-.001	-.079	.001	-.083	.017	-.201
Residence (1=Rural)	-.005	-.001	-.000	-.001	.021	.057
Ethnicity (1=Mainland)	-.030	-.014	-.056	-.138	-.094	-.673**
No education	---	---	---	---	---	---
Primary education	-.271**	-.291**	-.290**	-.361**	-.263**	-.561**
More than primary education	-.670**	-.505**	-.874**	-.884**	-.441**	-.252
Constant	-7.664	-8.242	-6.799	-7.612	-2.061	-6.944
-2 LL	9,793.9	9,514.9	9,018.9	7,707.4	6,440.7	
Δ -2LL$_{Year}$	13.2**	10.2**	41.7**	49.6**	4.76	

** p < .01 * .01 < p < .05 ^ .05 < p < .10

Table 4: Adjusted rates of specific functional difficulties and limitation severity in Taiwan among those 65 and older, across survey waves, and a comparison to 1993 U.S. rates

	1989	**1993**	**1996**	**1993 U.S.[a]**
Specific Limitation				
Has at least one difficulty	47.8	44.7	43.3	
Has difficulty lifting[b]	40.7	39.7	37.0	28.5
Has difficulty climbing stairs[c]	31.5	24.3	29.3	33.5
Has difficulty walking[d]	25.2	17.9	19.6	28.6
Limitation Severity				
Mild difficulties	29.0	32.2	29.0	
Moderate difficulties	61.6	58.1	60.8	
Severe difficulties	9.4	9.6	10.3	

[a]From Freedman and Martin, 1998, Table 3. These rates adjust for age, sex, marital status, race, ethnicity, education, ownership of liquid financial assets, and region of residence.

Table 5: Adjusted one-year transition probabilities for specific functional difficulties, using 1989 and 1993 as start of period, by originating status, (with mortality adjusted probabilities in parentheses)*

		END OF PERIOD STATUS			
Originating Functional Status	Start of period	No difficulty	Has difficulty	Died	P
No difficulty					
With any	1989 (N=1,280)	.861 (.891)	.105 (.109)	.034	.085
	1993 (N=1,655)	.844 (.868)	.129 (.132)	.027	(.059)
	Net Change	-.017 (-.023)	+.024 (+.023)	-.007	
Lifting	1989 (N=1,483)	.870 (.904)	.092 (.096)	.038	.031
	1993 (N=1,810)	.862 (.885)	.112 (.115)	.026	(.079)
	Net Change	-.008 (-.019)	+.020 (+.019)	-.012	
Climbing	1989 (N=1,737)	.907 (.947)	.051 (.053)	.043	.000
	1993 (N=2,255)	.878 (.910)	.087 (.090)	.035	(.000)
	Net Change	-.029 (-.037)	+.036 (+.037)	-.008	
Walking	1989 (N=1,929)	.921 (.961)	.037 (.039)	.041	.019
	1993 (N=2,449)	.914 (.945)	.053 (.055)	.033	(.019)
	Net Change	-.007 (-.016)	+.016 (+.016)	-.008	
Has difficulty					
With one or more	1989 (N=1,155)	.070 (.077)	.838 (.923)	.092	.001
	1993 (N=1,321)	.107 (.115)	.824 (.885)	.070	(.001)
	Net Change	+.037 (+.038)	-.014 (-.038)	-.022	
Lifting	1989 (N=1,001)	.064 (.070)	.839 (.930)	.098	.000
	1993 (N=1170)	.120 (.130)	.801 (.870)	.079	(.000)
	Net Change	+.056 (+.060)	-.038 (-.060)	-.019	
Climbing	1989 (N=795)	.119 (.134)	.770 (.866)	.110	.112
	1993 (N=729)	.107 (.117)	.811 (.883)	.082	(.317)
	Net Change	-.012 (-.017)	+.039 (+.017)	-.028	
Walking	1989 (N=642)	.113 (.129)	.762 (.871)	.126	.372
	1993 (N=537)	.108 (.120)	.791 (.880)	.101	(.639)
	Net Change	-.005 (-.009)	+.029 (+.009)	-.025	

*Transition probabilities adjust for age, sex, marital status, rural/urban residence, ethnicity and education.

Table 6: Unadjusted limitation severity transitions, including having no difficulties, by year of origin

	END OF PERIOD LIMITATION SEVERITY STATUS					
	Has no difficulties	Mild	Moderate	Severe	Died	Total
ORIGINATING FUNCTIONAL LIMITATION SEVERITY IN 1989						
Has no difficulties (N=1,176)	60.7	11.6	16.2	2.0	9.6	100.0
Mild (N=286)	34.6	16.4	28.7	3.5	16.8	100.0
Moderate (N=671)	13.1	9.4	36.1	9.1	32.3	100.0
Severe (N=118)	0.9	2.5	19.5	19.5	57.6	100.0
			P = .000			
ORIGINATING FUNCTIONAL LIMITATION SEVERITY IN 1993						
Has no difficulties (N=1,478)	66.0	10.5	16.1	1.3	6.1	100.0
Mild (N=339)	39.8	14.5	29.8	4.7	11.2	100.0
Moderate (N=704)	15.3	8.0	48.6	10.1	18.0	100.0
Severe (N=131)	0.8	0.8	12.1	27.3	59.1	100.0
			P=.000			

Table 7: Adjusted one-year transition probabilities for the direction of limitation severity change, using 1989 and 1993 as start of period, by originating status (with mortality adjusted probabilities in parentheses)*

		END OF PERIOD STATUS				
Originating status	Start of period	Improved	Remained in originating state	Worsened	Died	P
Mild	1989 (N=286)	.165 (.180)	.617 (.671)	.137 (.149)	.081	.008
	1993 (N=339)	.247 (.263)	.506 (.539)	.187 (.199)	.060	(.034)
	Net Change	+.082 (+.083)	-.111 (-.132)	+.050 (+.050)	-.021	
Moderate	1989 (N=671)	.094 (.105)	.767 (.861)	.030 (.033)	.110	.034
	1993 (N=704)	.119 (.127)	.775 (.833)	.037 (.039)	.070	(.352)
	Net Change	+.025 (+.022)	+.008 (-.028)	+.007 (+.006)	-.040	
Severe	1989 (N=118)	.113 (.138)	.708 (.862)	.000[a]	.179	.447
	1993 (N=132)	.083 (.102)	.731 (.898)	.000	.187	(.380)
	Net Change	-.030 (-.036)	+.023 (+.036)	.000	+.008	

*Transition probabilities adjust for age, sex, marital status, rural/urban residence, ethnicity and education.

[a]This transition is not possible given originating status.