

EDUCATIONAL ATTAINMENT AND TRANSITIONS IN FUNCTIONAL STATUS AMONG OLDER TAIWANESE*

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Despite considerable research examining the influence of socioeconomic status on health, few studies have considered this relationship as it pertains to older adults in non-Western societies. We attempt to ascertain the influence of education on changes in physical functioning in a rapidly developing country. Data come from the 1989 Survey of Health and Living Status of the Elderly in Taiwan and a follow-up interview in 1993 (N = 4,049, age = 60+). Individuals are conceptualized to be in a state of functional independence or functional limitation at the time of origin, based on their ability to perform three physical functioning tasks. The outcome at the follow-up interview is categorized as functionally independent, limited, or dead, allowing for six probabilities, one from each state of origin to each outcome. These are calculated using a multinomial logit model, controlling for other factors often thought to be associated with health transitions. High levels of educational attainment result in a decreased incidence of functional limitation for those originating in a state of independence. Contrary to expectations, however, education has little influence on those who originate functionally limited. Thus, higher education plays a substantial role in primary prevention of morbidity, delaying the onset of disability, but other factors are more important once limitations begin. We speculate on the reasons behind these findings, including that the results may be culturally dependent.

There is a lengthy history of research examining the relationship between socioeconomic status and health and mortality in Western societies (Antonovsky 1967; Fox 1989; Williams and Collins 1995). Almost unanimously, these investigations show that those with high socioeconomic status are advantaged in a number of health-related areas. For instance, lower socioeconomic status has been associated with a greater risk of experiencing both chronic conditions and mortality (Kitagawa and Hauser 1973; Rogot, Sorlie, and Johnson 1992; Winkelby, Fortman, and Barrett 1990). England's "Black Report" of 1980 suggested that despite more egalitarian health-care policies, gradations in health status still existed in that country (Townsend and Davidson 1982). Inequalities in health by socioeconomic status have

been well documented in the United States and Canada (e.g., Hay 1988; Pappas et al. 1993; Rogers 1992; Rogers, Rogers, and Belanger 1992; Williams 1990), throughout European nations (Fox 1989; Illsley and Svenson 1990), and in other more developed societies, such as the U.S.S.R. (Dennis et al. 1993). Some have even noted growing disparities over time (Feldman et al. 1989).

More recently, this line of research has expanded to include studies that concentrate on older adults, the group at greatest risk of experiencing morbidity and mortality. These studies have revealed that variation in health by socioeconomic status persists into later ages (Guralnik et al. 1993; Kaplan et al. 1993; Victor 1991). In terms of mortality, there appears to be substantial divergence among educational groups of younger elderly along with convergence in rates of mortality at very old ages (Elo and Preston 1995). Even at the more advanced ages, tangible disparities in health by socioeconomic status have been found (Thorslund and Lundberg 1994), but others have suggested that the differences are minimal among the oldest old (House et al. 1992). Although the issue of the magnitude and timing of convergence by age remains unresolved, variation by socioeconomic status at older age groups (60 or 65 years of age and older) has been amply demonstrated across different health measures. Camacho et al. (1993) found education to be associated with better functioning, measured as the ability to perform 18 various self-maintenance, mobility, and physical performance tasks, among the oldest-old. Rogers et al. (1992) showed a strong association between education and disability, measured by seven activities of daily living, such as bathing and dressing. Robert and House (1996) demonstrated that socioeconomic indicators are associated with various health dimensions, including function, the existence of chronic health conditions, and subjectively defined health.

Despite the strong tradition of research on the relationship between socioeconomic status and health among older adults, several questions remain. One is the degree to which relationships observed mainly among Western industrialized nations hold in other settings. Establishing the persistence and magnitude of this connection across diverse societies can assist in identifying the dynamics underlying the relationship. It is therefore important to assess these differences in areas where cultural norms and values differ from those commonly found in Western societies. We study older adults in Taiwan, a society with vastly different social arrangements, levels of economic development, and cultural traditions, than is typical in the West. The social and cultural dif-

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ferences may be important in shaping socioeconomic health differences that may arise from differences in the health-care system (e.g., differences in access to care, or the preference for traditional medicine), health behaviors (e.g., cultural and social influences on diet, smoking, and drinking), and knowledge about the connections between behavior and health. Moreover, other factors, like strong family relationships, might mitigate the relationship between socioeconomic status and health found elsewhere.

As a setting for such a study, Taiwan combines a number of interesting properties. It is a newly industrialized country that has undergone rapid demographic and economic change over the last 40 years while maintaining many societal arrangements typical of Chinese culture, including a patriarchal/patrilineal family system that has as its ideal the formation of joint and extended households of parents with married sons (Weinstein et al. 1994). The total fertility rate has dropped from nearly 6 children in 1949 to less than 2 today. Expectation of life at birth is well over 70, and more than three quarters of the population live in cities of 50,000 or more. Current projections expect more than 21% of the population to be 60 or over by 2020. Taiwan has also been transformed economically from a fairly poor, agricultural economy to a prosperous, industrialized one. The percentage of the labor force in agriculture has dropped from around 45% to around 10% over the last 30 years (Directorate General Bureau for Accounting and Statistics 1996). It has developed a strong health infrastructure, with over 16,000 medical care facilities and nearly 120,000 health personnel. At the same time, many older Taiwanese follow traditional folk practices, and medical colleges specializing in the training of traditional Chinese practitioners are still prevalent in Taipei.

Recent research has established that differences in the prevalence of functional disorders by socioeconomic status may be the net result of differences in rates of incidence and rates of recovery (Crimmins and Saito 1993; Rogers, Rogers, and Belanger 1990). This finding leads to a second challenge involving modeling and analyzing transitions in health over time on measures that can reflect these fluctuations in health. Movements in and out of states of functional dependence, normally measured as the ability to perform a variety of physical tasks such as those associated with self-maintenance (e.g., preparing meals or doing housework) or those necessary for general functioning (e.g., walking or crouching), have been detected even among the very old (Manton 1989). Moreover, recent evidence in the United States points to a decrease in age-specific prevalence rates of functional disorders, attributed to better rates of recovery and lower rates of incidence (Crimmins, Saito, and Reynolds 1997; Manton, Corder, and Stallard 1993).

Longitudinal databases, which provide more reliable information on changes in health status than do cross-sectional studies and reduce problems of endogeneity and selection in modeling, allow for informed examinations of health transitions. Several studies have investigated changes in the physical functioning of older adults as determined by socioeconomic status and a number of other covariates thought to in-

fluence changes in this health status, such as age, gender, ethnicity, social support, and health-related behaviors (Crimmins, Hayward, and Saito 1996; Kaplan et al. 1993; Liu et al. 1995; Rogers et al. 1992). The underlying model in these analyses is that health-status outcomes are a function of physiological factors, access to health services, health behaviors, and psychosocial attributes such as levels of stress, the degree of social support, and the strength of social networks (House et al. 1992). The assumption that socioeconomic status is related to transitions in functional status generally holds across these studies, although both Crimmins et al. (1996) and Liu et al. (1995) show mixed influences, perhaps suggesting a more complex dynamic. Few studies of transitions in health, however, have looked at non-Western societies (but see Liu et al.'s 1995 study of Japan), and none have analyzed developing or newly industrialized nations.

In the current study, we use longitudinal data from Taiwan to examine the role of education, net of other factors, in changes in physical functioning. Given that the educational system in Taiwan has undergone rapid transformation, the current study may serve as an important benchmark for future studies. The future elderly in Taiwan will have a different educational distribution, with shifts in the social origins of the more educated. It will be instructive to monitor the effect of these changes on the relationship of education to health. Moreover, the topic is of policy interest to Taiwan and other countries in East and Southeast Asia, many of which are undergoing similar societal transformations. Increases in the number and proportion of older adults in these societies suggests that studying levels and differences in health outcomes may help to address future health-care needs and related costs (Martin 1988).

EDUCATION IN TAIWAN

Given our focus, the history of education in Taiwan and the educational mix among older Taiwanese merits further attention. Taiwan was under Japanese control from 1895 to 1945. Among the changes introduced by the Japanese was an expansion and modernization of the school system, which greatly enlarged the proportion of the population that received a basic education and enrolled more girls. In 1905 less than 5% of the Taiwanese school-aged population was enrolled in elementary school. This increased to 25% in 1920 (40% of males and 9% of females) and to 78% in 1944 (81% of males and 61% of females). At the same time, the Taiwanese were effectively barred from post-primary education during the Japanese colonial period, and relatively few obtained a secondary school or higher education (Hermalin, Liu, and Freedman 1994; Tsurumi 1977). A second important influence was the influx of 1 million or more Nationalists from Mainland China in the period 1940–1950 in the aftermath of the Chinese Civil War. Those arriving were predominantly young males, many of them soldiers and officials. These Mainlanders made up 22% of the population aged 60 and older in 1989, the sample currently under study; about 50% of them have a junior high school or higher education compared with about 10% of the native Taiwanese.

Thus, among older people in Taiwan at the time of our study, there was a large proportion who had spent their formative years in a traditional agricultural society, but who had also spent a significant portion of their adult lives in a rapidly changing environment with new opportunities, ideas, and goods coming to the fore. There was also a sizable minority of Mainlanders who had spent their formative years often under wartime conditions and as migrants to a new environment. A priori, one might expect those with greater education to be advantaged in terms of health because of their likely advantage in terms of access to health resources, knowledge, and living conditions. However, as members of a relatively small elite growing up when knowledge of efficacious health behaviors and practices were limited, their nutritional, drinking, and/or smoking behaviors may have affected their health more adversely compared with the general population.

CONCEPTUAL FRAMEWORK

The conceptual framework underlying the analysis is shown in Figure 1. The transitions we consider are indicated in the enclosed box. Individuals originate in a state of functional independence or functional limitation. We consider each group separately and monitor their movements between states over time. Given the flexibility involved in functional transitions, individuals who begin in a state of independence may remain so over time or may become limited. Those who begin in a state of limitation may improve to independence or may remain limited (Guralnik et al. 1993; Liu et al. 1995; Rogers, Rogers, and Belanger 1989). Thus, functional independence and limitation are considered to be nonabsorbing states, and the movement between states over time is dynamic, resembling a Markov process (Goodman 1962). In addition to maintaining or changing states of physical functioning, each individual is subject to the risk of death over the period. We include this competing risk as one absorbing state. Studies that rely on retrospective reports must limit their samples to survivors and risk biasing the estimated transitions.

The probability of experiencing a particular transition in functional health is denoted by p_{ij} , where i represents the state at the point of origin (functionally independent or limited), and j indicates the state at destination (functionally independent, functionally limited, or dead). The six transition probabilities are labeled $p_{Ind-Ind}$ (independent to independent), $p_{Ind-Lim}$ (independent to limited), $p_{Ind-Dead}$ (independent to dead), $p_{Lim-Ind}$ (limited to independent), $p_{Lim-Lim}$ (limited to limited), and $p_{Lim-Dead}$ (limited to dead).

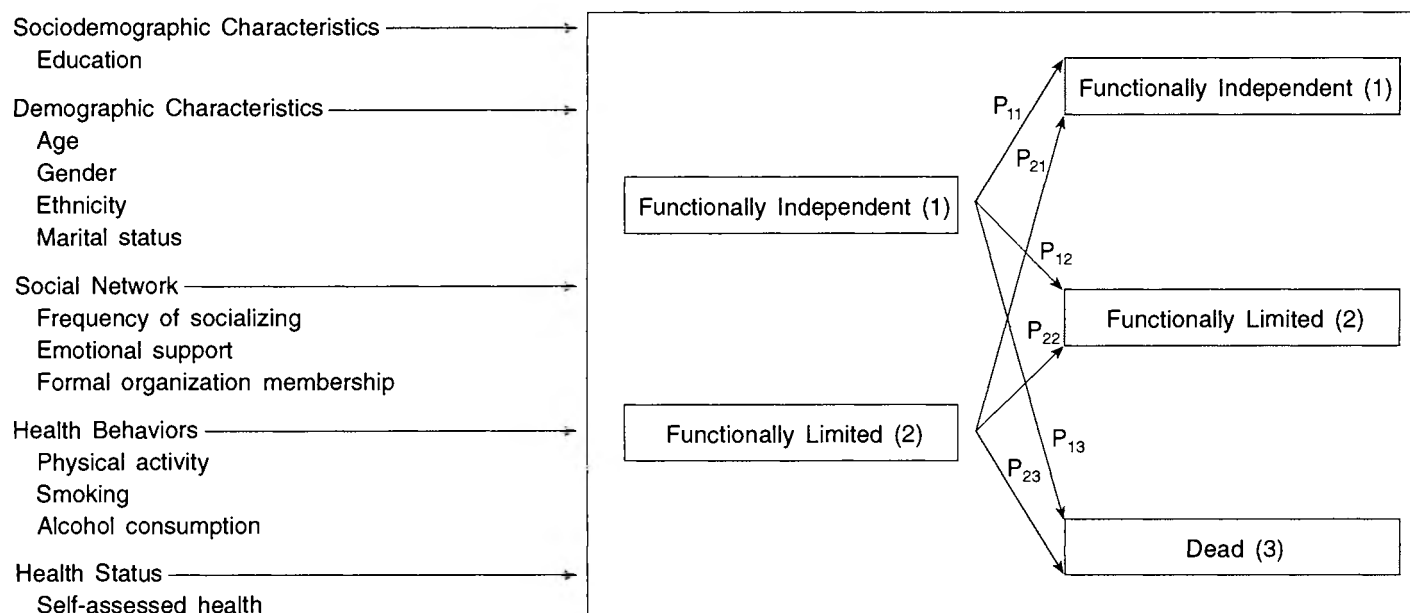
To the left of the enclosed box in Figure 1 are the perceived influences on the six transition probabilities. We focus on the socioeconomic effects and use educational attainment as our socioeconomic measure. Various socioeconomic characteristics may relate to specific facets of health in different ways (Williams and Collins 1995), but there are good reasons to use education as a measure of status, particularly in studies of developing countries such as Taiwan. Education is the one measure of status that remains constant throughout adulthood, and this is salient when studying older adults. Although other

measures of socioeconomic status correlate with education, it is more difficult to sort out the causal connections between them and health. Income, for instance, may have a reciprocal relationship with health, as the income of those with poor health may decrease as a result of their inability to work, sometimes referred to as a drifting effect. There has been some debate, particularly among British scholars, regarding the proportion of socioeconomic inequalities that can be explained by deteriorating health (Carr-Hill 1987). Although education may also be subject to some reverse causality (Smith and Kington 1995), the overall influence is likely to be much less than when considering other measures of status. In developing countries, education is a more easily accessible and valid piece of information than is income or occupation. In these nations, older people often have multiple sources of income, including monetary assistance from family members. The use of occupation raises the issue of adequate prestige scores for developing countries. As a practical problem, many older people are retired and have had multiple jobs in the past. Furthermore, because of occupational hazards, it may be difficult to separate the socioeconomic-status dimensions from the specifics of the job. From an empirical standpoint, there is some evidence that education is the measure of socioeconomic status most highly correlated with health (Winkelby et al. 1992). Overall, education seems to be the most expeditious choice for a measure of socioeconomic status in the context of a developing country.

We hypothesize that, over time, those with high educational attainment will experience more favorable transitions than will those with low educational attainment. That is, those with high educational attainment will be more likely to remain independent and to improve from a state of limitation to one of independence; those with less education will be more likely to remain limited, to move from independence to limitation, or to die. There are a number of reasons to expect these results. Education may influence both access to (through its association with income), and utilization of, existing health services. Those with less education tend to be less informed about resources and are less able to afford quality care; those with more education are likely to have a better understanding of preventive health measures and behaviors. This understanding may be accrued directly through schooling or may be learned through better access to health-related resources, like the media and informational books and guides about health care and health-care practices.

More recently, there have been strong arguments supporting a psychosocial connection between education and health (Williams 1990). For example, Ross and Wu (1995) argued that education affects health through a sense of personal control over one's life, which is enhanced with increased education, and through the benefits provided by social-support networks, which tend to be stronger among those who are better educated. House et al. (1992) showed empirical connections between a variety of health measures and measures of stress, social support (including marital status, formal and informal social contacts, and perceived quality of support), self-efficacy, and health-related behaviors

FIGURE 1. MODEL OF TRANSITIONS IN FUNCTIONAL STATUS



(including smoking and alcohol consumption). They also demonstrated that much of the association between socioeconomic status and health can be explained by these psychosocial factors.

We consider, as covariates with education, exogenous factors like age and sex, which have been shown to influence health status at older ages, and variables reflecting access to health care, health behavior, and psychosocial influences. This might imply a more complex model than that shown in Figure 1, in which the exogenous factors (education, age, and sex) affect the mediating psychosocial influences (social support and health behaviors). Ideally, one would examine the direct and indirect effects of the exogenous factors on the transitions of interest, but the methodology for definitive estimation is not at hand. Therefore, we introduce all the factors as covariates in order to determine whether there is a net effect of education after including these intermediate variables. All of these covariates are measured at baseline. To show the level of relationship of education to the other variables, we present the correlation matrix for the covariates in Appendix Table A1.

Demographic covariates are age, gender, marital status, and ethnicity. It is clear that advancing age will influence health. In addition, there is much past research that demonstrates differences in health and mortality by gender (Verbrugge 1980, 1989; Waldron 1985). Women live longer than men but tend to suffer from a higher incidence of functional impairment in old age. Being married is often thought to have favorable influences on health and mortality (Gliksman et al.

1995; Ortmeyer 1974). Ethnic differences have been found to relate to variations in health at older ages (Rogers et al. 1992). Although Taiwan is a relatively homogenous population ethnically, there is a major distinction between individuals who came from mainland China after World War II. These mainlanders tend to have distinct characteristics that could influence health outcomes. Mainlanders are overrepresented in certain occupational groups, such as in the government sector, resulting in differential access to pensions and health care. Mainlanders also have different family structures, life experiences, and behavioral characteristics that may influence their health. Therefore ethnicity may account for certain life experiences and access that cannot be accounted for by other measures. We control for ethnic differences by considering mainlanders versus other Taiwanese as separate ethnic groups.

Social support and social network have been strongly implicated as factors that may explain the interplay between education and health (House et al. 1992). These factors are important determinants of health, recovery from chronic illness, and mortality (see, for example, Berkman and Syme 1979; Cohen and Syme 1985; House, Robbins, and Metzner 1982). We have chosen several social-network and social-support indicators that either directly measure the quantity and quality of support or act as proxies to account for the interplay between these factors. First, we include, frequency of socializing with friends and family, which indicates the quantity of social support that is available to an older person. A measure of emotional support is included as a subjective assessment of the quality of social interactions. We use

membership in formal organizations to account for formal sources of support outside of family or close friendship networks. The degree of involvement in these organizations may act as a buffer to stressful events and may provide increased meaning and sense of accomplishment to an elder's life, which have been shown to be influential in determining health status in later years (Coleman and Iso-Ahola 1993; Fitzpatrick et al. 1991).

Health behaviors relate to knowledge about health practices and prevention. We include a measure of the frequency of physical activity and measures of smoking and alcohol consumption. We expect that those who engage in more healthful behaviors will have more favorable transitions.

Finally, transitions in functional status will be a function of health status at the time of origin. For example, those who experience certain chronic conditions, like arthritis, will be less likely to recover from a functional limitation than will others. On the other hand, those who suffer from a stroke or a chronic heart condition may be more likely to die in the transition period. Furthermore, there could be differences in rates of recovery depending on the severity of the difficulties at the time of origin. In order to account for general health status at the time of origin, we use self-assessed health as a proxy. Research undertaken in Western countries has shown self-assessed health to be strongly associated with other health conditions, such as levels of functional status, and to be a good predictor of both mortality and changes in functional abilities (Idler and Kasl 1995; Mossey and Shapiro 1982). There has been less systematic research on the predictive value of self-evaluated health in developing countries. Liu, Hermalin, and Chuang (1998), however, show its importance in predicting mortality in Taiwan, and we assume that this indicator will be an adequate measure of current overall health status.

MATERIALS AND MEASURES

Data for the analysis come from the 4,049 respondents aged 60 or older who participated in the 1989 Survey of Health and Living Status of the Elderly in Taiwan, and 3,155 survivors who responded to a follow-up survey in 1993. The survey, conducted by the Taiwan Provincial Institute of Family Planning in conjunction with the Population Studies Center at the University of Michigan, involved a multistage national probability sample. The response rate in 1989 was 92%. The low refusal rate also ensures generalizability of the findings to the total population of older adults in Taiwan. Attrition is always an issue in longitudinal surveys, and the higher the rate of attrition, the more the cause for concern of biasing results. The rate of attrition here is relatively low: The follow-up survey achieved a response rate of 90%. In Appendix Table A2, we compare the composition of the missing respondents with that of the initial 1989 sample. Although the missing respondents appear to differ somewhat demographically from the initial sample (e.g., those missing are more often not married), their health characteristics—based on number of limitations and self-assessed health measures—do not seem to differ widely from those of the respondents in the later survey.

Our outcome measure is physical functioning, and we categorize respondents as either functionally independent or limited at the time of origin. We refer to physical functioning as the ability to carry out daily activities and tasks. These may relate to activities of daily living (ADL) necessary for daily survival, like bathing and preparing meals, or to instrumental activities of daily living (IADL), which are necessary for maintaining a living environment, such as housework. They may also relate to tasks, such as lifting or climbing stairs, that indicate functional abilities that are not necessarily tied to specific survival or maintenance tasks. The term disability has been defined as an "inability or limitation in performing socially defined roles and tasks expected of an individual within a sociocultural and physical environment" (Nagi 1991:315). Defined this way, ADL and IADL limitations reflect the existence of a disability. The inability to perform a general functioning task, such as climbing stairs or walking a given distance, is regarded as a functional limitation, that is, an inability not tied to a socially defined role (Verbrugge and Jette 1994). Hence, ADL and IADL limitations tend to be confounded by role expectations, norms, and living circumstances, which can differ across societies and cultures. It is important to recognize that role expectations, and therefore the measurement of a disability, may be different in Taiwan than in Western societies, where nearly all of the literature on ADL and IADL is conducted. On the other hand, functional limitations relating to general physical tasks may be more comparable cross-culturally because they determine what one can do rather than what one actually does (Verbrugge and Jette 1994).

At both interviews, respondents were asked about their ability to perform a number of functional tasks that can be classified as ADL, IADL, and general physical functioning activities. We use three of these tasks to determine the functional state of individuals at origin and destination. First, we consider the ability to climb stairs and to walk 200–300 meters. These are general functioning tasks and should not be overly influenced by cultural circumstances. To capture a more serious limitation, we also include one ADL task, the ability to bathe oneself. Liu et al. (1995) also considered these tasks in their examination of Japan. Using these tasks therefore enables us to compare two Asian societies with close historical ties.

Functioning abilities often follow a hierarchical pattern so that a few well-selected activities can be used as a proxy for a detailed battery of functional tasks. Some of this can be found in our data and among these three items. For instance, if an individual reports only one limitation, often it is climbing stairs. The second most often cited difficulty is walking, while bathing problems appear to arise only among those with problems climbing stairs and walking. Because this is a general pattern, we use more than one item to gain a clearer picture of functioning. Although bathing, as an ADL, is amenable to environmental changes that could influence ability, changes in this activity are not likely to occur without changes in at least one of the other two activities. For example, an individual who can perform all three tasks in the

earlier survey is likely to report problems with bathing in the second survey only if he or she also reports problems with walking or climbing stairs. Problems with bathing, however, are sometimes independent of problems with other functions. Thus, there are limitations that cannot be accounted for by tasks relating only to general physical functioning.¹

Individuals who indicate that they have any degree of difficulty in conducting a task are considered to have a limitation. Table 1 displays the percentage distribution of the number of functional limitation problems experienced by older adults in Taiwan in 1989 and 1993. Also displayed are percentages who reported problems with specific tasks. The percentages are similar in the two survey years. For instance, about 71% of respondents reported problems with none of the three activities in 1989, and 73% reported no problems in 1993. About one quarter of respondents reported problems with stairs in both years, while bathing problems were reported by less than 6% of respondents at both interviews.

To study transitions, we treat those who, in 1989, had problems with any one of the three functional ability items as *functionally limited*. Those without these problems are considered free of functional disorders and are classified as *functionally independent*. Respondents at the 1993 follow-up interview are reclassified into three states: *functionally independent*, *functionally limited*, and *dead*. Of those who were originally independent, 76% remained independent in 1993 compared with 31% of those who were limited at origin; of those who were independent at origin, 15% were limited in 1993 compared with 40% of those who were limited at origin; and of those who were independent at origin, 9% were dead by 1993 compared with 30% of those who were limited at origin.

Any study that uses self-reported measures of health is susceptible to the potential misreporting of health status. For instance, misreporting of health status may vary by level of education, biasing the main association in question. Subjective variation in the reporting of health could result from different interpretations of health-related questions, which could certainly vary by education; different perceptions of health that may vary by socioeconomic status; an unwillingness to report a limitation; or day-to-day variation in health. Our dependent variable is constructed using items that are relatively objective given the nature of self-reported health data. That is, most individuals are aware of whether they have problems with day-to-day, functionally related tasks such as climbing stairs, walking, and bathing. Still, it is wise to note that health has a subjective component that could influence results.

Educational attainment is measured by total years of formal schooling. Gender, marital status, and ethnicity are

1. In our analyses, we considered each of these tasks individually and in various combinations. It is not possible to reach reliable conclusions using bathing only, as only a small percentage of respondents report these difficulties. In other instances, the results do not differ substantially from those reported here. In fact, the results we find with a combination of these three tasks mimic, to a great extent, the results based on climbing stairs and on climbing stairs and walking combined.

TABLE 1. PERCENTAGE DISTRIBUTION OF NUMBER OF FUNCTIONAL-LIMITATION PROBLEMS AND SPECIFIC PROBLEMS OF OLDER ADULTS IN TAIWAN, 1989 AND 1993

	1989	1993
Number of Limitations		
Percentage with no limitations	70.9	73.4
Percentage with 1 limitation	11.8	11.7
Percentage with 2 limitations	12.1	9.2
Percentage with 3 limitations	5.2	5.8
Total ^a	100.0	100.1
Percentage Who Have Problems With:		
Stairs	25.9	23.8
Walking	20.0	17.3
Bathing	6.0	6.3
Number of Respondents	4,049	3,155

^aTotal for 1993 does not sum to 100.0 due to rounding.

coded as dummy variables in the manner indicated earlier. Age is measured in years.

For each of the social-network factors, a higher score indicates a larger and more significant social network. Frequency of socializing is based on the response to the question "How often do you socialize with family, friends and neighbors?" The response categories range from *daily* (scored 3) to *never* (scored 0). Emotional support is constructed with a composite index of satisfaction with the support received from three sources: (1) spouse; (2) children, children-in-law, and grandchildren; and (3) friends, neighbors, and other relatives. For each source, respondents were asked if they are *very satisfied* (score of 3), *satisfied* (score of 2) or *not satisfied* (score of 1) with the emotional support received. The amount of satisfaction is the sum of these three items, divided by the number of applicable responses, creating an index ranging from 1 to 3. Finally, a dummy variable is created from responses to formal organization membership. Membership in any organization is coded as 1.

The first of the health-behavior variables, physical activity, is an index constructed from the responses to two items: the frequency of participating in sports and the frequency of going for walks. Each item is measured on a scale ranging from 1 (*infrequent*) to 3 (*very frequent*), with the resultant index ranging from 2 to 6. Next, dummy variables are created from responses to questions about current drinking behavior and current smoking behavior, although there is no measure for amount of alcohol consumed or number of cigarettes smoked. Finally, the self-assessed health score ranges from 1 (*poor health*) to 5 (*excellent health*).

Table 2 presents descriptive statistics for the explanatory variables for those originating as functionally independent and those originating as functionally limited. As we would expect, those who were functionally limited at origin,

TABLE 2. MEANS AND STANDARD DEVIATIONS OF EXPLANATORY VARIABLES, BY FUNCTIONAL STATUS IN 1989

Variable	Functionally Independent in 1989		Functionally Limited in 1989	
	Mean	Standard Deviation	Mean	Standard Deviation
Socioeconomic Variable				
Years of education	4.47	4.75	2.29	3.76
Demographic Variables				
Age (years)	66.98	5.65	70.96	7.27
Gender (1 = female)	0.37	0.48	0.56	0.50
Marital status (1 = married)	0.66	0.47	0.51	0.50
Ethnicity (1 = mainlander)	0.25	0.43	0.16	0.37
Social-Network Variables				
Frequency of socializing	1.66	1.30	1.32	1.33
Emotional support	2.19	0.48	2.10	0.49
Organization membership (1 = member)	0.12	0.33	0.08	0.28
Health Behaviors				
Physical activity	2.76	1.99	1.72	1.87
Smoking (1 = smokes)	0.38	0.49	0.27	0.44
Alcohol consumption (1 = drinks)	0.26	0.44	0.10	0.30
Health-Status Variable				
Self-assessed health	3.59	0.98	2.54	0.95

on average, have lower educational attainment and are older than those who were functionally independent. Women are more frequently represented in the limited group: Whereas 37% of the independent sample is female, women represent 56% of the limited group. Mainlanders and married individuals have greater representation in the functionally independent than in the limited group. There is some difference between the two groups in terms of the social-network variables, but the differences are not great. For example, the average score for frequency of socializing is 1.7 for those who were independent and 1.3 for those who were limited. Finally, those who were independent have higher mean scores for physical activity, smoking, and drinking.

ANALYSIS

The analysis proceeds, first with a discussion of univariate changes in functional status. Next, we observe patterns of bivariate association between education and changes in functional status. Finally, we use a multinomial logit approach to examine the independent effects of all predictors on the probability of movement from states of functional independence and limitation in 1989 to functional independence, limitation, and death in 1993. The multinomial logit model is specified as:

$$P_{ij} = \frac{\exp(X'_{ij})}{\sum_{j=1}^3 \exp(X'_{ij})}$$

where $i = 1, 2$ and $j = 1, 2, 3$.

We use this model to construct one transition model for each state of origin. The baseline probabilities are denoted as $p_{Ind-Ind}$ and $p_{Lim-Lim}$ (that is, the probability of remaining in the state of origin), and the log-odds of other transitions are evaluated in comparison with the baseline ($\log [p_{Ind-Lim}/p_{Ind-Ind}]$ and $\log [p_{Ind-Dead}/p_{Ind-Ind}]$ for the first transition model, and $\log [p_{Lim-Ind}/p_{Lim-Lim}]$ and $\log [p_{Lim-Dead}/p_{Lim-Lim}]$ for the second transition model).

It is hazardous to draw inferences about changes in probabilities from the regression coefficients estimated for a multinomial logit model (Greene 1993). Therefore, we follow a method of converting log-odds to marginal effects in which all explanatory variables, except the variable under examination, are controlled with their values taken as sample means. These marginal effects are scale dependent, as variation in baseline values of the control variables leads to changes in the predicted probabilities. However, a logistic curve approximates a straight line except at its extreme ends; thus, the marginal effects tend to remain fairly consistent over such changes in the zones where most cases are located.

RESULTS

We begin the analysis by examining the distribution of functional limitations in 1993 by the number of limitations reported at baseline in 1989. These results are depicted in Table 3. Most of those who began with no limitations reported a similar status in 1993 (75.7%). Almost 15% of these indi-

TABLE 3. PERCENTAGE DISTRIBUTION OF OUTCOME IN 1993 BY NUMBER OF FUNCTIONAL LIMITATIONS IN 1989

Outcome in 1993	Number of Limitations in 1989			
	Zero	One	Two	Three
Percentage with 0 limitations	75.7	44.3	28.9	5.3
Percentage with 1 limitation	8.1	17.2	15.0	2.1
Percentage with 2 limitations	4.3	14.2	21.5	4.8
Percentage with 3 limitations	2.5	6.0	9.6	21.3
Percentage dead	9.4	18.3	25.1	66.5
Total ^a	100.0	100.0	100.1	100.0
Number of Adults	2,571	431	447	188

^aTotal for two limitations in 1989 does not sum to 100.0 due to rounding.

viduals reported limitations in 1993, and 9.4% died by 1993. For those with limitations at origin, there was a greater probability of both limitations and death in 1993, and this probability was greater with higher numbers of limitations reported. Only 44% of those who began with one limitation, 29% of those with two limitations and 5% of those with three limitations reported no difficulties at the follow-up interview. Clearly, the greater the number of limitations at origin, the less the likelihood of recovery. Furthermore, the likelihood of death between 1989 and 1993 is strongly associated with functional status at time of origin. The percentage who died increased steadily from about 9% of those with no initial limitations to about 67% of those with three initial limitations. Yet, these data show that there is significant movement into and out of the states of functional limitation.

Next, we examine the bivariate associations between educational attainment and transitions in functional status. Table 4 presents the percentages of those with limitations, without limitations, and dead in 1993 by educational attainment, controlling for functional state at origin, for the total sample, and for two age groups separately. We categorize educational attainment into four groups that represent no education, primary school (1-6 years), some junior high school (7-9 years), and more than junior high school (10 or more years). For those with no limitations in 1989 (upper panel), there is clearly a strong association between education and functional-status outcome. For those with no initial limitations, about 69% of those with no schooling reported no limitations in 1993, whereas about 86% of those with 10 or more years of schooling reported the same outcome status. Similarly, almost 21% of those with no schooling reported some limitation and 11% died, compared with only about 6% and 7%, respectively, of those with 10 or more years of schooling. The chi-square statistic is highly significant for this association ($\chi^2 = 71.494, p < .000$). The panels representing the age groups 60-69 and 70 years and older reveal similar patterns for those who originate with no limitations.

Education is strongly correlated with changes in functional limitations only among those whose original status was independent. For those who began with some limitation in 1989, the pattern is not as clear. For the total sample, the chi-square probability is only .074; for the two age groups, the result is even less significant. The bivariate associations may be confounded, of course, by other factors. Hence, the multivariate analysis becomes crucial for confirming these observed patterns. Further, some of the cell sizes in this table are small, and interpretations must be made with caution. Bivariate associations controlling for other factors, like gender and marital status, were also performed. Though not shown here, the results of these analyses also revealed significant associations with education for those originating with no limitations and no apparent association with education for those who originated with limitations regardless of the additional control measure.

Tables 5 and 6 present the results of the multinomial logistic regression models predicting transitions in functional status. This multivariate procedure treats education as a continuous variable, thereby eliminating some of the prediction bias that may occur given the small cell sizes observed in the bivariate results. Results from the multinomial procedure indicate transition probabilities for a one-unit change in education, which will represent a one-year change rather than an increase in one educational level. The likelihood ratio reported is distributed as chi-square, and both models fit well. Although the multinomial results in Table 5 are important for establishing significance, we will refer to the marginal effects displayed in Table 6 when discussing the strength and direction of the relationships. For continuous variables, the marginal effect shows the change in a transition probability for a one-unit change in the explanatory variable, fixing all other variables at their means. For dummy variables, the marginal effect shows the change in a transition probability for a value of 1 versus a value of 0 with respect to that variable.

For those originating from a state of independence, education has a significant influence on the transition from independence to disability, with more education decreasing the probability that individuals will make such a transition. The effect of education on the transition from independence to death is insignificant. These results mimic those found in the bivariate analysis. The marginal effects in Table 6 show that, when other factors are controlled, for each additional year of education, the probability of remaining independent increases by .76%, while the likelihood of becoming functionally limited decreases by .67%. On the other hand, the effects of education for those originating from a functionally limited state are much lower and are insignificant. Thus, both the bivariate and the multivariate analyses suggest that education appears to be associated with physical functioning transitions only for older Taiwanese who do not initially have limitations.

Though our primary aim is to determine the associations between education and transitions in health, the covariate associations are worth noting. Of the demographic characteristics, statistically significant associations are found for age, gender, and marital status for those beginning in a state of

TABLE 4. OUTCOME STATUS IN 1993 BY LIMITATIONS IN 1989 AND EDUCATIONAL ATTAINMENT, TOTAL SAMPLE, AND TWO AGE GROUPS

1993 Outcome	No Limitation in 1989				Some Limitation in 1989			
	No Education	1-6 Years of Education	7-9 Years of Education	10+ Years of Education	No Education	1-6 Years of Education	7-9 Years of Education	10+ Years of Education
Total Sample								
Percentage with no limitation	68.5	79.4	81.6	86.1	28.6	34.2	31.0	43.5
Percentage with some limitation	20.9	12.2	8.6	6.5	41.0	40.3	31.0	23.9
Percentage dead	10.6	8.4	9.8	7.4	30.5	25.5	38.1	32.6
Total ^a (%)	100.0	100.0	100.0	100.0	100.1	100.0	100.1	100.0
N	1,115	879	255	310	742	263	42	46
Adults Aged 60-69								
Percentage with no limitation	76.3	82.9	86.7	89.8	41.2	39.2	31.0	53.8
Percentage with some limitation	16.9	10.3	6.9	5.1	40.2	43.9	37.9	23.1
Percentage dead	6.8	6.8	6.4	5.1	18.6	16.9	31.0	23.2
Total ^a (%)	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.1
N	705	691	203	255	301	148	29	26
Adults Aged 70 or Older								
Percentage with no limitation	55.1	66.5	61.5	69.1	20.0	27.8	30.8	30.0
Percentage with some limitation	27.8	19.1	15.4	12.7	41.6	35.7	15.4	25.0
Percentage dead	17.1	14.4	23.1	18.2	38.4	36.5	53.8	45.0
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	410	188	52	55	440	115	13	20

Note: χ^2 values for those with no limitation in 1989 and with some limitation in 1989 are, respectively, 71.494 ($p < .000$) and 11.489 ($p < .074$) for the Total Sample, 37.120 ($p < .000$) and 7.110 ($p < .311$) for the sample of Adults Aged 60-69, and 14.640 ($p < .023$) and 8.628 ($p < .196$) for the sample of Adults Aged 70 or Older.

^aColumns may not sum to 100.0 due to rounding.

independence. As expected, those who were older had a greater likelihood of functional limitation and death at the follow-up interview and a lesser likelihood of remaining in a state of independence. Compared with women, men who were independent in 1989 had an 11.4% greater chance of dying by 1993. These results confirm much previous literature on the relationships between gender, health, and mortality. In addition, married individuals have a greater probability of remaining independent over time.

Similar results are found for demographic characteristics and functional transitions for those who began in a state of limitation, although marital status is significant only for the transition from functional limitation to independence. Each year of age decreases the probability of recovery by 1.7% and increases the probability of death by 1.8%. Among

those originating from a functionally limited state, women show a greater likelihood of remaining limited but a much lesser probability of dying than do men. Marital status increases the probability of recovery from a functionally limited state by 15.7%.

As expected, the self-assessed health measure displays a strong association with health transitions for those originating from functionally independent and functionally limited states. This finding confirms previous research regarding the validity of self-assessed health as a proxy for overall health status and as a good predictor of future health and mortality. It also demonstrates that health status at the time of origin has substantial influence on ultimate health outcomes.

Several health-behavior measures substantially influence health transitions. For those originating in a state of in-

TABLE 5. RESULTS OF MULTINOMIAL LOGISTIC REGRESSION PREDICTING TRANSITIONS IN FUNCTIONAL STATUS OF OLDER ADULTS IN TAIWAN, 1989 TO 1993

Explanatory Variables	Functionally Independent in 1989		Functionally Limited in 1989	
	Limited in 1993	Dead in 1993	Independent in 1993	Dead in 1993
Socioeconomic Variable				
Years of education	-0.065**	-0.021	-0.009	0.008
Demographic Variables				
Age (years)	0.079**	0.092**	-0.054**	0.074**
Female	0.246	-0.732**	-0.159	-0.628**
Married	-0.216*	-0.579**	0.289*	-0.227
Mainlander	-0.393	-0.232	0.270	0.023
Social-Network Variables				
Frequency of socializing	-0.008	-0.067	0.045	-0.004
Emotional support	0.004	-0.076	-0.036	0.057
Is a member of an organization	-0.191	-0.135	-0.114	-0.093
Health Behaviors				
Frequency of physical activity	-0.026	0.019	0.065	-0.081
Smokes	0.289*	0.018	0.118	0.615**
Drinks alcohol	-0.100	-0.527**	0.384	-0.376
Health-Status Variable				
Self-assessed health	-0.344**	-0.396**	0.443**	-0.312**
Intercept	-5.463**	-5.910**	2.111*	-4.681**
Likelihood Ratio	3,197.8681		1,839.1619	
Sample Size	2,484		947	

* $p < .05$; ** $p < .01$

dependence, alcohol consumption appears to decrease the probability of death somewhat and to increase the probability of remaining independent by 8.6%. Previous research has suggested that moderate drinking has favorable influences on health transitions (Kaplan et al. 1987). In Taiwan, drinking tends to be moderate: Our data show that more than one half of those who reported drinking drink once a week or less. As would be expected, smoking substantially increases the probability of becoming functionally limited for those who begin in a state of independence, while it increases the probability of dying for those who originate in a state of limitation by over 21%. The marginal effects suggest that physical activity has a favorable influence on health transitions, although these coefficients are not statistically significant.

In short, we have found the expected associations with many of the covariates. This is the case with our social-network variables in terms of their direction. For instance, among those who begin in a state of independence, those who socialize more frequently, have greater emotional support, and are members of organizations have a greater probability of remaining independent and a lesser likelihood of dying. These associations are not, however, statistically sig-

nificant. Perhaps these particular social-network variables, often used in similar research in Western societies, are less valid in non-Western settings. Alternatively, much of the influence of social support may be accounted for by other covariates. On the other hand, despite the longitudinal nature of our data, there remain serious questions of endogeneity regarding the social-support variables, and these may confound the results. There are aspects of the social milieu that change as a result of physical functioning, like the quantity of support one might expect and garner from family members and the opportunity for social interaction. But in societies like Taiwan, where the family holds much responsibility in the care for older adults, negative changes in functioning may result in increased interaction, an effect that would mute the influence of social support on transitions: Those who are prone to making unfavorable transitions may receive more support in response to their condition. Similarly, initial levels of social interaction may be highly dependent on physical functioning at baseline, and changes in functioning may result in increased social interaction over time, although we have not measured changes in social support.

TABLE 6. MARGINAL EFFECTS OF EXPLANATORY VARIABLES ON TRANSITION PROBABILITIES OF FUNCTIONAL STATUS OF OLDER ADULTS IN TAIWAN, 1989 TO 1993

Explanatory Variables	Functionally Independent in 1989			Functionally Limited in 1989		
	Independent in 1993	Limited in 1993	Dead in 1993	Independent in 1993	Limited in 1993	Dead in 1993
Socioeconomic Variable						
Years of education	.0076	-.0067	-.0008	-.0026	.0003	.0022
Demographic Variables						
Age (years)	-.0138	.0079	.0060	-.0171	-.0013	.0183
Female	.0461	.0676	-.1138	.0295	.1795	-.2088
Married	.1150	-.0352	-.0798	.1570	-.0284	-.1286
Mainlander	.1066	-.0815	-.0251	.1113	-.0785	-.0328
Social-Network Variables						
Frequency of socializing	.0048	-.0002	-.0145	.0099	-.0058	-.0043
Emotional support	.0041	.0012	-.0052	-.0121	-.0017	.0136
Is a member of an organization	.0545	-.0390	-.0155	-.0343	.0516	-.0172
Health Behaviors						
Frequency of physical activity	.0014	-.0029	.0016	.0203	-.0006	-.0197
Smokes	-.0598	.0628	-.0030	-.0446	-.1659	.2104
Drinks alcohol	.0856	-.0113	-.0744	.2179	-.0209	-.1971
Health-Status Variable						
Self-assessed health	.0521	-.0304	-.0216	.0718	-.0921	.0203
Sample Estimate	.7993	.1241	.0765	.3089	.4418	.2494

CONCLUSION

We examined the relationship between education and transitions in functional status among older Taiwanese as a way of broadening research on the relationship between socioeconomic status and health to non-Western countries. In keeping with a long line of past research, we found that education had a significant and substantial negative effect on the probability of moving from a state of independence in 1989 to a state of functional limitation in 1993. The strong predictive effect of education was observed in bivariate analyses and was sustained in the multivariate analyses even in the face of other strong correlates such as age and gender. In this sense, education may reflect various lifetime opportunities in terms of income, access to health care, diet, behavioral factors, and other psychosocial factors (e.g., stress and social support) that go beyond what is captured by a traditional set of correlates such as those examined in this study.

In contrast, higher education had little influence on the functional health transitions of those who originated limited in 1989. In addition, we found no significant associations between education and death between 1989 and 1993. Although these latter findings were contrary to our expectations, they are not without precedent. Liu et al. (1995) found that education decreased the probability that older

adults in Japan without any difficulties would report limitations after a three-year period, but transition probabilities with regard to education were insignificant for those who originated with at least one functional problem. Crimmins et al. (1996) found that older Americans with low educational attainment were more likely to die if they originated without functional problems, but not if there was some original functioning disorder present. Together, these findings suggest that the role of education is complex and varies by specific transition.

There are several explanations that can account for the insignificant association between education and functional transitions among those who began in a state of functional limitation. First, the results may be partly a function of inconsistent reporting that is systematic by levels of education. Such a result would occur if, for example, those with low levels of education were more likely than those with high levels of education to report limitations at the time of origin and/or less likely to report them at the follow-up interview. Second, there may be a systematic difference in the severity of functional disorders that arise and are reported. For example, if the health condition of those with high educational attainment is more robust, they may be less aware of, less bothered by, or more likely to avoid minor limitations. This would mean that when the highly educated report a limita-

tion, it is likely to be a severe problem that is more difficult to recover from.

Third, the results may be culturally dependent and may be a function of factors such as the role of the family and its relation to older adults. Like most societies in Asia and other developing areas of the world, Taiwan considers the health care of older adults to be a family-related concern. Older adults often live with their married sons and are cared for by their daughters-in-law; hence, there is frequent contact among family members (Hermalin et al. 1992). There may be some related interaction factors that are associated with the care of older adults, such as the quality of care provided by family, that were unavailable for this analysis but could help to explain the transition patterns. Moreover, the strong system of familial support in Taiwan may have a direct influence on the nature of the recovery process. For instance, both the pattern of coresidence and the quantity of informal care may be selective based on health status, with those who are functionally limited being more likely than those who are functionally independent to coreside with family and receive care. Thus, all older adults, regardless of levels of education, would receive a similar quantity and quality of assistance, which would empirically reduce or mute the influence of education in the recovery process. Further, socioeconomic factors have changed dramatically for the current cohort of younger adults in Taiwan: The children of today's elderly have much higher levels of education and income, and older adults with limitations who were uneducated are likely to be cared for by chil-

dren who have high levels of schooling. Rather than the educational attainment of the elderly, the educational level of the care-giving children may be the important predictor of recovery. Although we cannot unequivocally support this argument with the available data, it is intriguing that Liu et al.'s (1995) study of Japan resulted in strikingly equivalent findings. Japan places a similar emphasis on familial care and has also experienced rapid socioeconomic growth over the last generation. The parallels between the two studies point to a possible cultural element that should be explored further.

A fourth explanation involves physiological factors: Perhaps a combination of the type of limitation, the severity of limitation, and one's physical propensity to recover from specific limitations are the key elements of these transitions. For instance, our data indicate that the possibility of recovery is lower for those who have more limitations and for those who have trouble walking and bathing as opposed to climbing stairs.

Finally, it is possible that only after the onset of a functional disorder can those with lower levels of education adopt measures either to improve their health or to limit the impact of an existing condition. These attempts may involve increasing doctor visits or taking other precautionary steps. The result is that behaviors become similar for those who are functionally limited regardless of education, and education no longer discriminates between those who recover or those who die.

In sum, our results confirm an important role for education in the prevention of morbidity—a result that has been

APPENDIX TABLE A1. CORRELATIONS BETWEEN MODEL COVARIATES

Variable	Education	Age	Gender	Ethnicity	Married	Frequency of Socializing	Emotional Support	Is a Member of an Organization	Frequency of Physical Activity	Smokes	Drinks Alcohol
Education	1.00										
Age	-.22**										
Gender	-.39**	.10**									
Ethnicity	.36**	-.11**	-.29**								
Married	.19**	-.28**	-.22**	-.01							
Frequency of Socializing	-.06**	-.03	-.05**	-.03	.01						
Emotional Support	.14**	-.05**	-.04**	-.03	.19**	.14**					
Is a Member of an Organization	.05**	-.03*	.00	-.05**	.03*	.09**	.04**				
Frequency of Physical Activity	.26**	-.10**	-.18**	.14**	.08**	.20**	.12**	.05**			
Smokes	.13**	-.12**	-.49**	.09**	.09**	.08**	.02	-.02	.03		
Drinks Alcohol	.18**	-.13**	-.33**	.16**	.10**	.06**	.02	.01	.10**	.31**	
Self-Assessed Health	.23**	-.13**	-.20**	.13**	.09**	.08**	.13**	.02	.26**	.11**	.16**

* $p < .05$; ** $p < .01$

found to be robust across societies and over time. Recent research has demonstrated that improvements in morbidity have important implications for reducing both the years and proportion of dependent life (Crimmins, Hayward, and Saito 1994). Although education has less potential for assisting in recovery from a limitation, it has great potential for providing years of independent life. This inevitably has implications for Taiwan and other rapidly developing societies facing the challenges of a population growing older. On the one hand, future cohorts of older adults will have higher levels of education than did preceding cohorts. On the other hand, any move away from traditional sources of support for the elderly may mitigate the gains from education, but verifying this possibility requires further study.

APPENDIX TABLE A2. COMPARING THE 1989 COMPOSITION OF FOUR SAMPLES

Variable	1989 Sample (N = 4,049)	Those Who Died (N = 550)	Missing in 1993 (N = 334)	Responded in 1993 (N = 3,155)
Education (%)				
None	50.4	61.2	43.0	49.1
1-6 years	30.8	25.1	24.9	32.4
7 or more years	18.9	13.7	32.1	18.5
Age (%)				
60-64	35.9	19.1	37.6	38.9
65-69	28.6	19.6	29.5	30.2
70 or older	35.4	61.3	30.9	30.9
Gender (%)				
Male	57.1	59.5	59.0	56.5
Female	42.9	40.5	41.0	43.5
Marital Status (%)				
Married	61.7	52.3	50.0	34.5
Not married	38.3	47.7	50.0	65.5
Ethnicity (%)				
Mainlander	22.3	16.7	38.9	21.6
Other	77.7	83.3	61.1	78.4
Number of Limitations (%)				
None	70.9	43.4	73.8	75.6
One	11.8	14.2	10.9	11.4
Two	12.1	20.1	9.7	10.9
Three	5.2	22.4	5.6	2.0
Self-Assessed Health (%)				
Poor	4.0	13.3	4.5	2.5
Fair	18.6	28.4	12.2	17.6
Good	38.2	36.5	36.0	38.8
Very good	21.8	14.9	24.4	22.7
Excellent	17.3	6.9	22.8	18.4

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