CHILDREN'S EDUCATION, INTERGENERATIONAL SUPPORT, AND ELDERLY PARENTS' HEALTH IN TAIWAN*

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This study uses longitudinal data to examine how adult children's education and support patterns affect their elderly parents' health transitions in Taiwan, after controlling for various socioeconomic characteristics of the elderly. Although we are unable to completely eliminate the possibility of reverse causal influences or selectivity, we find evidence that adult children's education promotes good health among their elderly parents. The mean years of adult children's schooling decrease the incidence of disability among the functionally independent elderly at the baseline, and enhance recovery from disability among the disabled elderly at the baseline for the six-year interval that followed. Data suggest that these effects are created mainly when children share their nonmaterial resources, including knowledge about health and health care systems. We speculate that this association between children's education and elderly health is unique to social contexts with a tradition of extended family systems and current rapid economic growth; however this hypothesis needs further tests in diverse social contexts.

INTRODUCTION

In the rapidly growing economies of East Asia, the gap between the lifetime incomes of younger and older generations is large. Whereas elderly populations in industrialized countries are often characterized as having wealth and political power, elderly persons in industrializing countries occupy, on average, a far lower socioeconomic status than do younger people. As industrializing countries have experienced dramatic economic growth, younger generations are increasingly better educated and more likely to occupy higher-earning jobs in the industrial and tertiary sectors than the current elderly population had been (Hermalin, 2000).

Because of such socioeconomic status (SES) gaps between the generations, adult children's financial, emotional, and social support is considered crucial for the wellbeing of their elderly parents. Accordingly, much research in

newly industrializing countries explores adult children's support for their elderly parents (Hermalin, 2000; Martin, 1990; Mason, 1992). The research, however, rarely explicitly assesses the consequences of intergenerational support for the wellbeing of the elderly. Using longitudinal data, this paper explores how adult children's support affects their elderly parents' health outcomes in a rapidly industrializing country, Taiwan. In addition to the effects of the explicit support that adult children provide for their elderly parents, we also examine the net effects of adult children's education on their parents' health transitions to further explore children's transfers of information and behavioral traits to their parents.

Pathways between Children's Education and Elderly Parents' Health

When adult children maintain close ties with their elderly parents, the nature of the impact of children's SES on elderly parents' health is expected to be, in principle, similar to those found in respondents' own SES and health. Then what are the known benefits of high SES for one's health? Numerous studies document strong, positive associations between SES and health status, but discussions regarding the precise mechanisms of SES-health relationships are inconclusive (Adler et al., 1993; NRC, 2001; Pappas et al., 1993; Smith, 1998, 1999). In this section, we discuss whether and how the known and hypothesized mechanisms of SES-health linkages may be relevant to the effects of adult children's education on their elderly parents' health outcomes in Taiwan.

One of the most obvious reasons for the associations between SES and health is the standard of living. High income means adequate nutrition and sanitary living environments, which help maintain good health. High SES among children can contribute to better living conditions for their elderly parents when children transfer their financial or other material resources to them. In our analysis, however, we take into account the amount of these financial transfers, as well as the value of co-residence with adult children, when determining the elderly parents' income. Controlling for these material resources, the remaining association between adult children's education and elderly parents' health status should be explained by reasons other than the standard of living. Previous studies find that health differentials by SES remain large even after controlling for the standard of living. In other words, among those who enjoy sufficient nutrition and sanitary environments, health differences by SES are still substantial (NRC, 2001; Williams and Collins, 1995).

Access to medical care provides another explanation for the linkages

between SES and health, and in newly industrializing countries this pathway may be particularly relevant for the association between adult children's SES and elderly parents' health. In Taiwan, the National Health Insurance program that includes self-employed workers and rural residents was launched only in 1995 (*Taipei Review*, 2001: 7). Children who are well-educated are more likely than their elderly parents had been to hold jobs in the formal sector, where employer-provided health care insurance is available. As family members, elderly parents can be included as beneficiaries of these health care programs. Consequently, this study will also take into account variables related to elderly persons' access to medical care.

While standard of living and access to medical care are indirect pathways between education and health, operating mainly through education's correlation with income and occupation, net pathways between education and health are likely to be one's knowledge of health and health care systems and behavioral adjustments. Education increases efficiency in transforming resources into health (Hayward et al., 2000; Smith, 1999). For example, educated people may seek medical care immediately when problems occur, thus preventing further deterioration and facilitating recovery. Articulate communication with medical professionals, such as doctors, nurses, and pharmacists, when expressing symptoms and receiving treatment instructions may help educated people maintain good health. Information about nutrition and other health matters may also lead more educated people to healthier eating habits, more exercise, and less involvement in such risk behaviors as smoking and alcohol consumption, compared to less educated people. Family members may share this knowledge and these behavioral traits (Caldwell and Caldwell, 1993; Smith and Kington, 1997).

An alternative pathway between SES and health is stress, particularly for those who occupy subordinate social positions (Adler and Ostrove, 1999; Marmot, 1999; Marmot et al., 1991; Smith, 1998, 1999; Williams and Collins, 1995). Evidence suggests that low SES multiplies the adverse effects of stress on health outcomes, probably due to the lack of resources to cope with it (Chande, 2001). Although much of the stress explanation has focused on work environments, some argue that psychological distress related to subordinate social status goes beyond workplace experiences to include various spheres of everyday life, as it is described as an "inability to fully participate in the society" (Marmot, 1999; NRC, 2001). In East Asian societies, where children's success brings honor to the entire family, adult children's social status may affect their elderly parents' health in the same manner as it affects the children's own health.

The Social Context and Children's Education Effects

   Modernization theory predicts that economic and social ties between generations will disintegrate with the processes of industrialization and urbanization (Cowgill and Holmes, 1972; Goode, 1963). Research findings, however, have shown persistent patterns of intergenerational support during the process of economic growth. Data from many developing countries in East and South East Asia demonstrate that most elderly persons either co-reside with their adult children or receive financial or instrumental support from them (Chan, 1999; DaVanzo and Chan, 1994; Knodel and Chayovan, 1997; Mason, 1992). More importantly, adult children are more likely to provide support for needy elderly parents than for well-off parents (Chan, 1999; Lee, 2000; Lee and Xiao, 1998). Research in the United States also demonstrates that kin networks remain strong despite a rise in average income levels, and that adult children and elderly parents provide assistance to each other (Bengtson and Harootyan, 1994; Litwak, 1965, 1985).

   Some researchers further argue that extended families function as corporate groups. During the process of rapid economic growth, parents make long-term arrangements to maximize their families' wellbeing. In rapidly growing economies, the demand for skilled labor increases and the returns to skills and knowledge are generally high in the labor market. Thus, parents invest family resources in children's human capital, with the expectation that parents will share the returns to their children's education in times of need, such as during old age or ill health (Lee, Parish, and Willis, 1994; Lillard and Willis, 1997). In Taiwan and Malaysia, adult children who received more education provide more financial support for their elderly parents than do adult children with less education, after controlling for their incomes. The findings suggest that adult children comply with the long-term arrangements that their parents had planned (Lee, Parish, and Willis, 1994; Lillard and Willis, 1997). Data from China and Korea show similar patterns of intergenerational arrangements (Lee, 2000; Lee and Xiao, 1998).

   Thus, we predict that in societies like Taiwan, where the extended family is the unit maximizing its members' wellbeing, adult children's education will play a positive role in their parents' health outcomes, comparable to those found in previous studies for respondents' own education. Indeed, previous research has addressed the positive effects of family members on the health outcomes of persons of different ages. Most notably, the effects of mother's education on infant and child mortality are well known, although the direct causal mechanisms are still debated (Caldwell and Caldwell, 1993;

Desai and Alva, 1998). Also, spousal SES is found to be relevant. In a study of people from two age groups, 51 to 61 and 70 or older, in the United States, Smith and Kington (1997) find that the spouse's education has a positive effect on respondents' health status, although the effect is weaker than that of respondents' own education. Smith and Kington argue that the education of family members functions similarly to one's own education for health outcomes. While these earlier studies consider only family members living in the same household, in the social context of Taiwan, we expect that adult children's education plays a significant role in their elderly parents' health, whether they live in the same household or not.

The Effects of Children's Support on Elderly Parents' Health

As discussed, a majority of adult children provide financial or material support for their elderly parents in the developing countries of East and South East Asia. Usually the amount of support given is relatively small, but adult children are still the major source of income for many elderly people in these countries (Knodel and Chayovan, 1997; Lilliard and Willis, 1997; Mason, 1992). For example, according to the Women and Family Life Survey conducted in Taiwan in 1989, about 15 percent of adult sons had provided for their parents an amount greater than that designated as the official poverty line, approximately 120 U.S. dollars per month, in the previous year (Lee, Parish, and Willis, 1994). The amount of resources shared through co-residence may be more substantial, although these transfers are not explicit. Emotional support is expected to enhance elderly parents' psychological wellbeing and hence improve physical health outcomes as well. This study will consider these three types of support: co-residence, emotional support, and financial support. All three types of support are expected to have positive effects on elderly persons' health.

Analytic Issues and Research Questions

One qualification in extending the previous findings on family SES and health outcomes to the case of adult children's SES and elderly health may be related to the cumulative nature of health outcomes. The literature emphasizes the importance of early environments for health outcomes later in one's life (Adler et al., 1993; Elo and Preston, 1992; Verbrugge and Jette, 1994). Adult children's SES and their support become relevant later in the life cycle, in late middle age or older. However, the length of exposure to adult children's circumstances still is expected to last as long as 15 to 35 years for most of the elderly, long enough to influence health outcomes.

Methodological concerns when examining the impact of adult children's SES on elderly parents' health include the possibilities of reverse causality and selectivity in the data (Goldman, 2001; Smith, 1999; Smith and Kington, 1997). Reverse causality refers to parents' health having affected adult children's SES, while selectivity refers to some unobserved traits of the elderly parents causing spurious relationships between the two variables: adult children's SES and elderly parents' health. Elderly parents' current health status is believed to be correlated with their past health status. It is also possible that parents' past health status had negatively affected children's schooling because of either large medical bills or the parents' low incomes. If so, a positive association between adult children's education and elderly parents' health could be observed due to the reverse causal influences, even though children's education did not have any positive impacts on their elderly parents' health outcomes. A selectivity problem is also possible. Parents who are more conscious of the importance of good health may have invested more resources in their children's education. Elderly persons' educational attainment may be the variable associated with such a link, but in this study elderly persons' education and other possible link factors, including spouses' education and couple income, are controlled, thus reducing the possibility of the selectivity problem. To further minimize the possibility of reverse causality and selectivity, we use longitudinal data and focus on changes in health status in later life.

Using cross-sectional data from Taiwan in 1989, Zimmer, Hermalin, and Lin (2001) find significant associations between adult children's education (measured by the highest level attained among siblings) and functional status of their elderly parents aged 60 or older (both the presence and severity of functional difficulties). In cross-sectional analyses, however, reverse causality and selectivity remain unchecked. In particular, reverse causality may be the case for the highest level of schooling among children for two reasons. First, later-born children generally receive higher levels of education than early-born children in rapidly growing economies like Taiwan (Parish and Willis, 1993). Second, the parents' health during the time of later-born children's higher education is expected to be highly correlated with their current health.

Short-term longitudinal data, however, do not necessarily provide unambiguous proofs of the causal influences of adult children's education on elderly parents' health. That is, even in longitudinal data, some unobserved health endowments of elderly respondents can create spurious associations between adult children's schooling and the elderly parents' functional ability transitions (Goldman, 2001). In our longitudinal analysis, we minimize

the possibility of such spurious associations by controlling for other health conditions at the baseline besides the dependent variable. In all, this longitudinal analysis should provide much more convincing insights than cross-sectional data about the effects of adult children's SES on their elderly parents' health outcomes.

Children's support is expected to have positive effects on elderly parents' health, but the possibility of reverse causal influences and selectivity poses the same methodological challenge as in the case regarding the effects of children's education. Furthermore, longitudinal analysis may worsen the measurement problem of children's support. Summing up the various types of irregular support often poses the issues of validity and reliability (Hermalin, 1999; Roan, Hermalin, and Ofstedal, 1996). In addition, in longitudinal analysis, family support measured at the time of a baseline survey may not be an accurate representation of support given for the entire time interval.

In sum, this study examines the net effects on elderly parents' health transitions of (1) adult children's educational attainment, and (2) adult children's support, including co-residence, emotional support, and financial support.

DATA AND METHODS

Data

Data are from the panel surveys of Health and Living Conditions of the Elderly conducted in 1989 and 1996. The National Institute of Family Planning (now the Bureau of Health Promotion) in Taiwan carried out an initial survey in 1989, based on a nationally representative sample of 4,049 respondents aged 60 or older. Follow-up surveys have been conducted in 1993, 1996, and 1999. This study examines the changes in elderly persons' health status between the 1989 baseline and the 1996 follow-up survey. We selected the 7-year period for several reasons. First, health status represents cumulative consequences of everyday life experiences, and 7 years seem to be long enough for adult children's education to have impacts on their parents' health. Too short a period (i.e., 4 years) may not fully reflect impacts of children's education through daily lives with or without major health-related events. On the other hand, too long a period (i.e., 10 years) may raise problems with regard to the measurement of other independent variables as, circumstances may change over time. Future research may examine elderly parents' health at all three follow-up surveys and compare the

effects of children's education across the time periods. Excluding 165 cases with missing values for either health measures or explanatory variables, the longitudinal analysis includes 3,884 cases, including 2,759 functionally independent and 1,125 disabled respondents as of 1989.

Measures of Health

The dependent variable is the self-reported measure, functional disability. Functional disability measures difficulty in daily life, and is considered one of the most direct measures of elderly persons' wellbeing. Our functional disability measure is the same as the one used by Liu, Hermalin, and Chuang (1998) and Zimmer et al. (1998), a composite of three indicators measuring the difficulty in bathing oneself, climbing two or three flights of stairs, and walking 200-300 meters. Each item has scores from 0 to 3: no difficulty at all, a little difficult, somewhat difficult, and unable to perform. This composite disability measure is treated as binary, no difficulty or any difficulty. The longitudinal analysis focuses on transitions between the two statuses: new incidence of disability for people who had no difficulty at the baseline, and recovery from disability for disabled people at the baseline.

The number of diseases and self-reported status of general health at the baseline are used as control variables, to eliminate possible reverse causality due to health endowment. The disease status considers four serious diseases: hypertension, heart problems, diabetes, and strokes. Information on cancer is not available in the 1989 survey. Self-rated general health includes scores 1 to 5, representing excellent, very good, good, fair and poor.

Other Variables

All independent variables in our longitudinal analysis are measured as of the baseline survey in 1989. Adult children's education is measured by mean years of schooling among all surviving children 18 years or older, regardless of their gender, marital status, and living arrangements. Children's support variables include co-residence, emotional support, and financial support. Co-residence has four categories: married sons present, with unmarried sons, with only daughters, and no coresiding children. The measure of emotional support is elderly persons' satisfaction with emotional support from their family members, with its score ranging from 1, not at all, to 5, very much. In the data, the amount of financial support is not specified separately and is included in the elderly couple's total income. However, information on the number of family members who provide financial support (a majority of whom is adult children) is available. We

assume that a larger number of persons providing financial support means that a larger proportion of the couple's income is coming from their children.

The multivariate analysis controls for elderly respondents' demographic and socioeconomic characteristics, access to medical care, and risk behaviors. Demographic variables include age, gender, ethnicity, and marital status. The variables of SES include elderly respondents' and their spouses' years of schooling and the couple's income. For widowed respondents, deceased spouses' years of schooling are considered. Other variables of elderly persons' SES, including lifetime occupation and types of property owned, were not found to be significant in a preliminary analysis, and therefore, they were not included in the main analysis for parsimony of the model. The survey provides data on spouses' incomes combined, but not separately for each spouse. Couple income refers to average monthly incomes from all sources for elderly respondents, and for their spouses, if present. In the survey, couple income was measured with seven categories, but our preliminary analysis did not find a smooth linear relationship between couple income and health. For parsimony, we group elderly couple's income into three categories: low, middle, and high. The value ranges are 0 to 10, 10 to 20, and 20 or more thousand Taiwan dollars (NT), with 10 and 20 thousand NT equivalent to approximately 380 and 760 U.S. dollars in 1989 respectively.

Access to medical care is measured in the 1989 data by the question of whether elderly respondents saw any (Western or traditional) doctors, nurses, or pharmacists for any purposes during the previous 12 months. Risk behaviors include smoking and alcohol consumption. For each item, the survey asked whether respondents had done it in the past, do it currently, or have not done it at all. For the analysis, we combine the first two categories into ever done, instead of focusing on current behavior.

Sample Characteristics

The statistics in Table 1 describe the respondents in the 1989 survey, who were 60 years old or older, excluding cases with missing values for either the dependent or independent variables. This provides the baseline sample for the longitudinal analysis. One noticeable statistic is the predominance of men in the sample, comprising 56% of the sample. Elderly populations in most other countries have substantially larger proportions of women because of women's longer life expectancy, but in Taiwan there was an influx of mainland soldiers during WWII, leading to a larger male popula-

TABLE 1. CHARACTERISTICS OF THE SAMPLE

	1989 Interview
Characteristics of the Elderly	
Age*	68.1
Female (female=1, male=0)	0.43
Mainlander (mainlander=1, other=0)	0.22
Unmarried (unmarried=1, married=0)	0.35
Years of schooling*	4.10
Spouse's years of schooling*	3.77
(Couple income, low, 10 thousand NT or less)	0.55
Couple income, middle (10-20 thousand NT)	0.28
Couple income, high (20 thousand or more NT)	0.17
Couple income missing	0.04
Use of medical care in the past year (yes=1, no=0)	0.87
Ever smoked (yes=1, no=0)	0.50
Ever drank (yes=1, no=0)	0.37
Children's Education and their Support for Elderly Parents	
Mean years of schooling*	9.15
Proportion of mean years of schooling missing	0.08
(Elderly not living with children)	0.29
Elderly living with married sons	0.47
Elderly living with unmarried sons	0.16
Elderly living with daughters only	0.08
Elderly feeling loved*	3.55
Number of persons giving financial support*	1.46
Sample size	3,884

Note: Numbers for the variables marked with asterisks (*) are the means. Other numbers are proportions.

tion. The average number of years of schooling among respondents is approximately four, which is equivalent to dropping out from primary school. The percentage who used any type of medical care during the one-year period prior to the 1989 survey is 87%.

The statistics for health measures are summarized in Table 2. In 1989, approximately one-third of the respondents (34.9%) had one or more of the four serious diseases. Among the sample surviving by 1996, about one-half (49.8%) had one or more serious diseases. The contribution of cancer to the difference between the two years is minimal, as the cancer prevalence is only about 1.5% in 1996. The most prevalent serious disease is hypertension; in both years, about two-thirds of those having diseases had hypertension. The subjective general health status also deteriorated over the two samples. The percentage of the sample that was functionally dependent increased by 10% over time (from 29.0% to 38.7%). The numbers at the bottom panel of

TABLE 2. HEALTH STATUS OF THE SAMPLE (PERCENTAGES)

	1989 Sample	1996 Sample		
Sample size	(3,884)	(2,776)		
Number of serious diseases[a]				
0	**65.1**	**50.2**		
1-4 (1-5, for 1996)	**34.9**	**49.8**		
1	23.8	30.6		
2	9.3	15.1		
3-4 (3-5, for 1996)	1.8	4.1		
Subjective health score[b]				
1=poor	3.6	11.0		
2=fair	18.0	17.6		
3=good	36.9	31.2		
4=very good	21.2	26.0		
5=excellent	16.8	4.8		
(Missing)	3.5	9.4		
Mean score among non-missing cases	3.30	2.96		
Functional disability score[c]				
0 (independent or not disabled)	**71.0**	**61.3**		
1-9 (dependent or disabled)	**29.0**	**38.7**		
1	9.8			
2	7.6			
3	2.8			
4-9	8.8			
Probability of transition by 1996:		To:		
		Independent	Disabled	Death	Attrition
From independent, i.e., not disabled, status	(2,759)	0.517	0.257	0.151	0.075
From dependent, i.e., disabled, status	(1,125)	0.244	0.324	0.404	0.028

[a]The measure considers five serious diseases: hypertension, heart problems, diabetes, stroke, and cancer. In 1989, cancer status was not asked. This measure is used as a control variable.

[b]The score ranges from 1 to 5: poor health, fair, good, very good, and excellent. This variable is also used as a control variable.

[c]The composite measure considers bathing oneself, climbing 2-3 flights of stairs, and walking 200-300 meters. Each item has scores from 0, no difficulty, to 3, unable to perform, and the sum ranges 0 to 9. The scale is considered dichotomous, whther a respondent has any difficulty or not. The longitudinal analysis focuses on transitions between the two states.

Table 2 show that changes in individuals' health status between 1989 and 1996 were quite substantial, more than what the aggregate trend suggests.

About 70% of elderly respondents were functionally independent in 1989, and, among them, 52% remained independent and alive, 26% experienced an onset of disability, 15% died, and 7% were lost through attrition by 1996. Among the disabled respondents in 1989, 33% remained disabled and alive, 24% regained functional independence, 40% died, and 3% were lost through

attrition by 1996. Thus, the proportion of functionally independent people who experienced an onset of disability and the proportion of disabled people who regained their functional independence are similar, about one-fourth. These statistics are roughly similar to those in the United States (e.g., Crimmins and Saito, 1993). While the most likely transition among functionally independent persons is to remain independent, for people functionally disabled in 1989, the likely pathway over the next seven years is either to die or recover, rather than remain disabled.

FINDINGS

Longitudinal Analysis: Incidence of and Recovery from Functional Disability

Two multinomial logit analyses of the factors associated with transitions in disability status are presented in Table 3. Refer to Appendix A for the three equations of the multinomial logit, and the three alternative ways to interpret the estimated coefficients. The first two columns in Table 3 present results from the multinomial logit analysis of the transitions from no functional difficulty in 1989, to disability and death by 1996. The last two columns show the results from the second multinomial model of the transitions from disability in 1989 to functional independence and death by 1996. In both analyses, the transition to the third option, attrition, is included and the results are presented in Appendix Table B1 for reference. Unattached elderly persons, such as those who are unmarried and not living with their children, were most likely to be lost through attrition.

Adult Children's Education

The equations in Table 3 show that adult children's education has a significant net effect on elderly parents' health status transitions, after controlling for elderly persons' demographic, socioeconomic and behavioral characteristics, children's support for the parents (emotional, financial, and co-residence), and elderly persons' baseline health status. Adult children's higher education promotes elderly parents' good health. In the first equation, children's mean years of schooling has a significant, negative effect on the incidence of disability. With a one-year increase in children's schooling, the logit of the onset of disability decreases by .04. If we transform the result into probability, per each year increase in children's schooling, the probability of disablement goes down by about one percentage point (i.e., .8%), similar to the effect of elderly persons' own years of schooling (probabilities are not presented in the table). As the standard deviation of children's schooling is

TABLE 3. TRANSITIONS IN FUNCTIONAL DISABILITY STATUS FROM 1989 TO 1996 AMONG TAIWANESE PERSONS AGED 60 OR OLDER IN 1989

| | Not disabled in 1989 | | | | Disabled in 1989 | | | |
| | Onset of disability by 1996 | | Death by 1996 | | Not disabled by 1996 | | Death by 1996 | |
	b	s.e.	b	s.e.	b	s.e.	b	s.e.
Intercept	-0.41	0.40	-1.03*	0.50	-1.47*	0.72	-0.74	0.68
Children's Education and their Support for Parents in 1989								
Mean years of schooling[†]	-0.04*	0.02	-0.01	0.02	0.07*	0.03	-0.01	0.03
Mean years of schooling missing (missing=1, not missing=0)	-0.30	0.24	0.09	0.25	-0.08	0.38	0.85*	0.37
Living arrangement (Elderly not living with children=0)								
Elderly living with married sons	-0.31**	0.12	0.03	0.14	-0.25	0.19	0.12	0.19
Elderly living with unmarried sons	0.09	0.16	0.10	0.19	-0.15	0.30	0.45	0.37
Elderly living with daughters only	0.32	0.20	0.14	0.26	0.41	0.34	0.32	0.32
Elderly satisfied with emotional support[†]	-0.04	0.07	-0.09	0.07	-0.04	0.12	-0.08	0.11
Number of financial support[†]	0.06*	0.03	0.06	0.04	-0.08	0.05	0.05	0.05
Characteristics of the Elderly in 1989								
Age[†]	0.11**	0.01	0.14**	0.01	-0.02	0.01	0.10**	0.01
Female (female=1, male=0)	0.43*	0.16	-0.49*	0.20	-0.34	0.25	-0.65*	0.27
Mainlander (mainlander=1,others=0)	-0.04	0.15	0.04	0.17	-0.12	0.27	-0.35	0.27
Unmarried (unmarried=1, married=0)	-0.03	0.12	-0.02	0.14	0.26	0.18	0.55**	0.17
Years of schooling[†]	-0.06**	0.02	-0.04*	0.02	-0.02	0.03	-0.01	0.03
Spouse's years of schooling[†]	-0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Spouse's years of schooling missing (missing=1, not missing=0)	0.05	0.31	0.33	0.32	-0.47	0.54	-0.31	0.47
Couple income (Couple income, low=0)								
Couple income, middle	-0.32**	0.12	-0.13	0.15	0.46*	0.22	0.27	0.22
Couple income, high	-0.29	0.16	-0.15	0.19	-0.12	0.31	-0.04	0.32
Couple income missing (missing=1, not=0)	-0.46	0.44	0.03	0.50	-0.64	0.76	0.89	0.51
Health care use (yes=1, no=0)	0.37*	0.16	0.01	0.17	0.60	0.38	0.21	0.33
Ever smoked (yes=1, no=0)	0.29*	0.15	0.35*	0.17	0.20	0.24	0.32	0.23
Ever drank (yes=1, no=0)	-0.04	0.12	-0.17	0.14	0.43	0.24	0.46	0.23
Baseline Health Status in 1989								
Number of diseases[†]	0.50**	0.08	0.58**	0.09	-0.29**	0.10	0.20*	0.09
Self-rated general health[†]	-0.24**	0.06	-0.30**	0.07	0.23*	0.09	-0.37**	0.09
Self-rated general health missing (missing=1, not missing=0)	1.28*	0.57	1.34*	0.61	1.07	0.82	1.71**	0.52
Log likelihood	-2,857	-			1,115			
Sample size	2,759				1,125			
Number of transitions	710		416		275		454	
(Probability of transitions[a])	0.257		0.151		0.244		0.404	

Note: Each analysis also has an option of attrition. The results are presented in Appendix Table B1.

Variables marked with [†] are continuous variables.

a. For respondents not disabled in 1989, the probability of transition to attrition is .075, and the probability of remaining independent is .517.

In the second equation, the probability of transition to attrition is .028, and the probability of remaining disabled is .324.

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

3.3 years, one standard deviation increase in children's schooling will lower the disability incidence by about three percentage points. In the second equation, children's mean years of schooling significantly increases the probability of regaining functional independence. Again, a one-year increase in schooling increases the recovery probability by about one percentage point (i.e., 1.2%).

The magnitudes of the effects are relatively small, but these longitudinal results provide clear support for the influences of children's education on elderly parents' health. Reverse causal influences are unlikely to account for the significant associations, since the analysis controls for elderly parents' various characteristics, including their baseline health scores, and hence it controls for their health endowments as of the baseline observation. Also, the consistent results from the onset and recovery equations strengthen our interpretation of the causal influences of children's education on elderly parents' health outcomes than vice versa.

The analysis controls for several factors related to material pathways between education and health, such as standard of living (i.e., elderly persons' and their spouses' education, couple income, and co-residence with children), access to health care, and health risk behaviors. So, the observed effects of children's schooling on elderly parents' health are likely to be related to adult children's transfers of non-material resources, such as knowledge about health and health care systems and social prestige. Possibilities how health knowledge can strengthen elderly persons' good health are diverse; for example, having information on which medical facilities would be most helpful for certain health problems, seeking medical care immediately after problems occur, and having nutrition information. Adult children's high social status may enhance confidence and skills in communicating with health professionals or may be the source of life satisfaction that leads to good health (e.g., Hayward et al., 2000; Smith, 1999). Smith and Kington (1997) report spousal education effects, and Caldwell and Caldwell (1993) discuss maternal education effects on children in developing countries.

To further explore whether the effects of children's education occurs through material transfers to their elderly parents, we performed an additional analysis with the education of only coresiding children, who are more likely to transfer material resources than are non-coresiding children (results are not presented). Results showed that education of only coresiding children does not have any significant effects on elderly parents' health transitions, rejecting the hypothesis that material transfers are the main pathways between adult children's education and elderly parents' health. We further

assume that the sharing of non-material resources between generations and the positive impact of adult children's schooling on elderly health outcomes are particularly likely in the social context of traditional extended family systems and rapid economic growth, such as that occurring in Taiwan. However, the test of this assumption will require further research both in similar and different social contexts, such as in East Asia and in other regions.

Adult Children's Support

As is often assumed by previous studies, elderly persons' co-residence with their married sons turns out to have a beneficial effect on elderly parents' health (Table 3). Functionally independent elderly persons who live with their married son(s) at the time of the baseline survey are less likely to experience the onset of disability than are those who do not live with any children. Recovery from disability is not affected by co-residence with married sons. Living with unmarried sons or with only daughters as opposed to living with no child does not affect elderly parents' health transitions.

On the other hand, elderly persons' perception of emotional support does not affect their health outcomes. Elderly respondents' satisfaction with emotional support from family members does not reduce the incidence of disability nor does it increase the chance of recovery from disability. It appears that subjective feelings are not important for disability status transitions in later life. Consistent with this interpretation, two measures of elderly persons' psychological wellbeing, depression (CES-D) and life satisfaction, also had no significant effect on their transitions in disability status in our preliminary analysis (results not shown). Another explanation for this non-significant effect of emotional support on elderly health is that it may be the result of a measurement problem. Perhaps emotional support at the beginning of the interval is not an accurate representation of emotional support for the entire interval, as discussed earlier.

The amount of children's financial support is included in the couple's income in our data. We suppose that, after controlling for the couple's total income, the number of persons providing financial support may represent the proportion of the couple's income coming from family support. The results in Table 3 show a positive effect of the number of persons providing financial support on the incidence of disability, controlling for the amount of total income. That is, the larger the proportion of the couple income from family support, the more likely are elderly persons to experience an incidence of disability. This seems to suggest that the health benefit of elderly persons' income is weaker when the income is from adult children, com-

pared to the case when the income is from elderly persons' own sources. This may be because children's support is irregular and inconsistent.

Elderly Persons' Characteristics

The findings in Table 3 regarding elderly persons' characteristics are generally consistent with those reported in previous studies (e.g., Berkman and Gurland, 1998; Thorslund and Lundberg, 1994; Zimmer et al., 1998). Older persons are more likely than younger ones to experience an incidence of disability as well as death. Women are more likely to experience the onset of disability, but show a lower mortality regardless of baseline disability status. Ethnicity has no association with disability status transitions. For respondents who were disabled in 1989, unmarried persons show significantly higher mortality than married persons, suggesting the importance of spousal caring for the disabled elderly.

Elderly persons' own schooling is negatively associated with the incidence of disability, as is the mean years of adult children's schooling. The magnitude of the effect is greater for elderly persons' own schooling than for their children's schooling. Interestingly, however, unlike their children's schooling, elderly persons' own schooling is not associated with recovery from functional disability. The results suggest that adult children's schooling is more important than elderly persons' own education for their health outcomes, when the elderly become ill. Children's knowledge of health and heath care systems seems to be particularly relevant in the process of coping with illness.

Years of schooling among elderly respondents' spouses, either deceased or surviving, do not have any additional effects on elderly persons' disability status transitions. Our additional analysis suggests that higher spousal education is beneficial for men's health but not for women's health (results not shown). Further research may be useful. Elderly couples' total income is negatively associated with the incidence of disability and positively associated with recovery from disability, but both associations are statistically significant only for the middle-income group and not for the high-income group. The effect of high income on recovery is not even positive. These income effects are rather puzzling. Disability measures the gap between individual functional capacity and the person's environment (Verbrugge and Jette, 1994). If high incomes help the elderly maintain functional independence through the availability of better environments, then only the most functionally incapable persons will be disabled among persons with high incomes. Thus, once disabled, high-income elderly persons may not

easily recover from disability. For corroboration, further analysis will be necessary.

The use of health care service is positively associated with the incidence of disability. A majority of the sample, 87%, used health care services. It seems that those who do not use health care services are a select group of people with good health that is not measured by the baseline health variables in the equation. The harmful effect of smoking is well known and reconfirmed with our data. Alcohol consumption, on the other hand, shows no association with disability status transitions. Obviously, the baseline health status, measured by the number of serious diseases and subjective general health status, has the strongest predictive power of transitions in disability status. These two variables have significant effects on all transitions.

SUMMARY AND CONCLUSION

This study examined how adult children's education and the provision of support to their parents affect elderly parents' health outcomes in Taiwan, using longitudinal data regarding the incidence of and recovery from disability. We examined the net effects of the relationships between variables, after controlling for elderly respondents' baseline health status, demographic and socioeconomic characteristics, health behaviors, and access to health care. Although we are unable to completely eliminate the possibilities of reverse causality or selectivity, we find evidence that adult children's education promotes elderly parents' good health. For elderly persons who were functionally independent at the time of the initial survey in 1989, each year's increase in their adult children's mean years of schooling decreases the incidence of disability over the following seven-year period by about one percentage point. For those who were disabled at the baseline in 1989, their children's schooling increases the probability of recovery during the same time interval. In the recovery equation, children's education is one of only two significant coefficients other than baseline health status. Elderly persons' own education decreases the incidence of disability, but does not increase the chance of recovery. Children's education seems particularly important in how their elderly parents cope with illness.

Evidence about the effects of adult children's support on their elderly parents' health is somewhat mixed. First, the beneficial effect of co-residence with married sons is confirmed. Co-residence with married sons significantly decreases the incidence of disability among those who were functionally independent in 1989. In the survey, the amount of financial support was

included in the elderly couple's total income and is not distinguishable. Controlling for the couple's total income, the number of family members who provide financial support may represent the proportion of the total income that is received from family members. Its positive effect on the incidence of disability seems to suggest that income from children's support may have a weaker effect on elderly persons' health outcomes than incomes from other sources. Elderly persons' perception of emotional support is not associated with their health status. Previous studies emphasize the importance of psychological wellbeing for physical health outcomes, but our finding suggests that subjective feelings do not affect disability status transitions in later life.

Other important findings are as follows. For health transitions in old age, respondents' own education, but not their spouses' education, has a significant effect. With its coefficient in the recovery equation not significant, elderly persons' own education is more limited than their adult children's education in promoting good health. Elderly couples' income, which includes transfers from their children, also has beneficial effects on their health outcomes. Smoking increases the incidence of disability, confirming its harmful effect on health. Utilization of health care during the previous year shows an association with poorer health outcomes in the longitudinal data analysis. This suggests that use of health care reflects poor health more than access to health care, even after controlling for the two measures of health at the baseline, number of serious diseases and self-rated general health. After controlling for various baseline circumstances, older elderly persons are still more likely to experience both disability and death than are younger elderly persons. Women are more prone to disability, but less prone to death than are men. Clearly, baseline health status, measured by the number of serious diseases and self-rated general health, is a major predictor of changes in disability status, even after controlling for several socioeconomic factors.

We speculate that adult children's education affects elderly parents' health status mainly through children's transfer of non-material resources to their parents, most of all, their knowledge about health and health care systems. The unique effects of children's education on their parents' recovery from disability support this speculation. Children's support, such as co-residence, emotional support, and financial support, is controlled in the analysis. Also controlled is a string of variables characterizing elderly persons, such as education (including spouses'), income, health behaviors, and access to health care. Thus, transfers of non-material resources seem to be the most plausible mechanism linking adult children's education to elderly

parents' health outcomes. The results also seem to correspond with previous findings regarding the roles of family members' education on health outcomes of persons of various ages, including the effects of maternal education on child mortality and spousal education on older adults' health outcomes (Caldwell and Caldwell, 1993; Smith and Kington, 1997).

In this study, we also conjecture that the effects of children's education on elderly parents' health outcomes are unique to social contexts with a tradition of extended family systems and current rapid economic growth. Earlier studies find that parents invest in their children's human capital and later in their old age receive repayment of their investment from these children. The net effects of adult children's education on elderly parents' health outcomes suggest that children's repayment of parental investment goes beyond explicit transfers. It appears that adult children fully share their non-material resources, such as knowledge about health and health care systems, with their elderly parents. Whether adult children's education will have the same effects in different social contexts remains to be seen. With rapid economic growth, many newly industrializing countries in Asia are expanding their public programs for the elderly. The findings of this study suggest that it is important for public programs to be formulated to incorporate and facilitate intergenerational relationships within the family rather than to replace familial roles.

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APPENDIX A: THE EQUATIONS OF MULTINOMIAL LOGIT

The multinomial logit model, like the binomial logit model, can be expressed in three different equations, with the left-hand side being: (1) the probability of choice j (2) the odds of choice j, and (3) the logit of choice j. Data consists of the values of vector xk and a choice in variable y, for each observation. (Subscript k goes from 1 to K, and refers to the explanatory variables. For simplicity, we omit this subscript in the equations.) For variable y, J+1 unordered outcomes can occur. For example, in Table 3, in the equation of the functionally independent sample, j goes from 0 to 3: 0=remaining functionally independent, 1= onset of disability, 2=death, and 3=attrition. The three equations are as follows, respectively.

(1)
$$\Pr(choice\_j) = \frac{\exp(B_j x_{jt})}{\sum_{j=0}^{J} \exp(B_j x_{jt})}$$

$j=0, ..., J$

where t indexes the observation, or individual, and j indexes the choices.

(2)
$$\frac{P_j}{P_0} = \exp(B_j x_{jt})$$

where p_j refers to Pr(choice_j), i.e., the probability of choice j, and p0 refers to the probability of choice 0.

(3)
$$\ln(\frac{P_j}{P_0}) = B_j x_{jt}$$

where ln denotes natural logarithm. The left-hand side is called the logit of choice j. Thus, for each format of (1), (2), and (3), J number of equations exist and are estimated simultaneously.

To further clarify the equations, one unit increase in x_k leads to the following changes in the left-hand side.

In equation (2), $(p_j/p_0)^*/(p_j/p_0) = e^{bj}$, where $(p_j/p_0)^*$ refers to the odds of choice j after xk is increased by one unit. This means that the odds of choice j changes multiplicatively; in other words e^{bj} is the ratio of odds, i.e., odds ratio.

In equation (3), $(\ln(p_j/p_0))^* - \ln(p_j/p_0) = b_j$, where $(\ln(p_j/p_0))^*$ refers to the logit of choice j after x_k is increased by one unit.

On the other hand, in equation (1) there is no simply way to present the change in the probability of choice j when x_k is increased by one unit. We just have to subtract p_j from p_j^* that is calculated after x_k is increased by one unit. This means that probability calculation involves the entire set of equations with different values of the x_k variable, and that the probability change caused by one unit increase in x is different at different values x_k (Greene 1998; Retherford and Choe 1999). Following the convention, we estimate the probability changes at the means of the interested variables, setting other explanatory variables also at their means.

APPENDIX TABLE B1. TRANSITIONS TO ATTRITION BY 1996 AMONG TAIWANESE PERSONS AGED 60 OR OLDER IN 1989

	Not disabled in 1989		Disabled in 1989	
	Attrition by 1996		Attrition by 1996	
	b	s.e.	b	s.e.
Intercept	-1.98	0.62	-2.25	1.69
Children's Education and their Support for Parents in 1989				
Mean years of schooling†	0.00	0.03	-0.07	0.08
Mean years of schooling missing				
(missing=1, not missing=0)	-0.22	0.32	-0.32	0.84
Living arrangement(Elderly not living with children=0)				
Elderly living with married sons	-0.78**	0.20	-0.95	0.51
Elderly living with unmarried sons	-0.40	0.23	0.31	0.58
Elderly living with daughters only	-0.08	0.28	-0.31	0.84
Elderly satisfied with emotional support†	-0.18	0.10	-0.04	0.27
Number of financial support†	0.04	0.05	0.04	0.13
Characteristics of the Elderly in 1989				
Age†	0.05**	0.02	-0.08*	0.04
Female (female=1, male=0)	0.40	0.26	-0.46	0.69
Mainlander (mainlander=1,others=0)	0.54**	0.20	0.64	0.59
Unmarried (unmarried=1, married=0)	0.68**	0.19	1.06*	0.45
Years of schooling†	0.03	0.02	0.00	0.07
Spouse's years of schooling†	0.02	0.03	0.12	0.07
Spouse's years of schooling missing				
(missing=1, not missing=0)	0.23	0.36	0.88	0.89
Couple income (Couple income, low=0)				
Couple income, middle	0.33	0.20	0.64	0.49
Couple income, high	0.40	0.25	0.36	0.76
Couple income missing (missing=1, not=0)	1.35*	0.52	-1.06	1.46
Health care use (yes=1, no=0)	-0.26	0.20	0.81	1.08
Ever smoked (yes=1, no=0)	0.29	0.21	-0.23	0.56
Ever drank (yes=1, no=0)	-0.22	0.18	-0.35	0.59
Baseline Health Status in 1989				
Number of diseases†	0.14	0.13	-0.49	0.25
Self-rated general health†	-0.07	0.09	0.03	0.23
Self-rated general health missing				
(missing=1, not missing=0)	-0.08	0.84	1.67	1.33
Log likelihood	-2857		-1115	
Sample size	2759		1125	
Number of transitions	207		31	
(Probability of transitionsa)	0.075		0.028	

Note: These attrition equations are part of the same multinomial logit models presented in Table 3.
*p < .05 **p < .01

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