

## Physical function trajectories, depressive symptoms, and life satisfaction among the elderly in Taiwan

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**Objective:** The purpose of this study was to examine the effect of physical function trajectories on emotional health and subjective well-being among the elderly in Taiwan.

**Methods:** Data was from a 6-year nation-representative panel for analysis. Physical function trajectories were categorized as independent, declined, disabled, improved, fluctuating, died well and died disabled. The effects of physical function trajectories on depressive symptoms and life satisfaction were examined by controlling for demographics, chronic disease, cognitive function and social support. Mixed linear modeling was used for analysis.

**Results:** Among the physical trajectory groups, differences were shown between depressive symptoms and life satisfaction. An increase in the difficulty of physical function also increases depressive symptoms and reduces life satisfaction. The died-well group showed a difference from the independent group in depressive symptoms and life satisfaction, but these who died without disability did have better emotional health and subjective well-being than the disabled survivors.

**Conclusion:** Coping strategies and supporting resources to help the disabled elderly to improve their successful aging is suggested in future research and health policies.

**Keywords:** physical function; disability trajectory; depressive symptoms; life satisfaction; successful aging

### Introduction

Maintaining good physical function is one of the components of successful aging (Rowe & Kahn, 1997). However, disability in physical function is common among the elderly, and the decline of physical function is part of normal aging. For the physically frail or disabled elderly, other dimensions of health (e.g. psychological and social health) can be maintained or improved. Although many researchers have explored the adverse effects of physical disabilities on the elderly, few have compared the patterns of physical function trajectories and studied how they influence psychological health and life satisfaction. In addition, in most studies mortality is viewed as an endpoint or as the worst outcome of health. The emotional health and subjective well-being of those who die but maintain good physical function up until their death have rarely been compared with those of living elderly. In this study, the effect of physical function trajectories on depressive symptoms and life satisfaction among the elderly in Taiwan was explored. The results in this study contribute to a better understanding of the impact of physical function trajectories on emotional health and subjective well-being of the elderly who experience the stress of disability, and further may provide implications for coping and improving successful aging when the decline or disability of physical function happens.

### Theoretical explanations

According to stress theory, stress may have a cumulative effect on health and longevity, and individual differences in resilience to stress may be modified by individuals' psychological and/or social characteristics (Finch & Seeman, 1999). Thus, if disability is viewed as a type of stress, it will have an effect on other dimensions of health. Pearlin and Skaff (1996), who combined the perspectives of stress and life course, explained that experiencing stress at one time in life might affect a person at a later point in life. They illustrated that a life-course perspective can sensitize stress in the incidence of certain outcomes (such as depression, physical illness, successful aging or life satisfaction), and help in observing the dynamic process of stress and its effect.

### Empirical findings

Many studies have described the effects of disability on depressive symptoms (Bruce, Seeman, Merrill, & Blazer, 1994; Harris, Cook, Victor, DeWilde, & Beighton, 2006; Harris et al., 2003; Prince, Harwood, Blizard, Thomas, & Mann 1998; Wada et al., 2004; Zeiss, Lewinsohn, Rohde, & Seeley, 1996). Some studies report that disability and depression have a reciprocal relationship or define depression as a risk factor of disability (Jiang, Tang, Futatsuka, & Zhang, 2004; Kempen, Ranchor, van Sonderen, van Jaarsveld,

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& Sanderman, 2006; Kivelä & Pahkala, 2001; Lenze et al., 2005; Ormel, Rijdsdijk, Sullivan, van Sonderen, & Kempen, 2002; Penninx et al., 1998; Penninx, Leveille, Ferrucci, van Eijk, & Guralnik, 1999; van Gool, Kempen, Penninx, Deeg, Beekman, & van Eijk, 2005). There have also been Chinese studies on the relationship between physical function and depressive symptoms (Chi & Chou, 2001; Chi et al., 2005; Chiu, Chen, Huang, & Mau, 2005; Jiang et al., 2004; Ku, Liu, & Tsai 2006). In recent studies, researchers have focused on the effect of the trajectory of physical function impairment on the trajectory of depressive symptoms (Taylor & Lynch, 2004). Social support or social resources, mastery of life, loss-related events, lifestyle and socio-economic factors have also been reported to be either risk or protective factors for depressive symptoms (Chi and Chou, 2001; Chi et al., 2005; Demura & Stao, 2003; Harris et al., 2003; Jang, Haley, Small, & Mortimer 2002; Lynch and George, 2002; Prince, Harwood, Blizard, Thomas, & Mann, 1997).

Life satisfaction usually is viewed as a holistic evaluation of successful aging. Physical function, perceived health, education, financial strain, interpersonal relations, social contacts and social support, and housing quality were found to be determinants of life satisfaction (Chipperfield & Havens, 2001; George, Okun, & Landerman, 1985; Newsom & Schulz, 1996; Sato, Demura, Kobayashi, & Nagasawa, 2002), including the studies conducted in Chinese societies (Cheng & Chan 2006; Ho et al., 1995; Ku, McKenna, & Fox, 2007). The effect of marital status on life satisfaction was inconsistent; some studies found it was significant for men but not for women (Chipperfield & Havens, 2001; Prince et al., 1998), whereas others reported that widowhood had a moderate effect (Cheng & Chan, 2006; George et al., 1985). Life satisfaction also is related to life trauma or loss-related events (Krause, 2004). Age is also found to be a moderator of life satisfaction (George et al., 1985).

Factors related to physical function trajectories have been reported in the past. Kempen et al. (2006) found that the risk factors for functional decline included old age, more depressive symptoms and low mastery regard of one's life, and the protective factors included younger age, good perceived health and self efficacy.

Advanced age (Guralnik, 1991; Palmore & Burchett, 1997) or age at death (Romoren & Blekeseaune, 2003) is related to a higher probability of physical disability. Impaired cognitive function usually accompanies disability, and impaired cognitive function is viewed as a warning of impending loss of physical function (Convinsky, Eng, Lui, Sands, & Yaffe, 2003; Greiner, Snowdon, & Schmitt, 1996; Raji, Ostir, Markides, & Goodwin, 2002; Wang, Larson, Bowen, & van Belle, 2006). Cognitive function was also found to be a predictor for sharp functional decline followed by death for the non-demented community dwelling elderly (Dodge, Du, Saxton, & Ganguli, 2006).

Although past studies have explored the relationship of physical function with emotional health and life satisfaction, some questions have not been resolved. First, in the past, the baseline physical function was used to predict later functional change. This was based on the assumption that physical function is a time-related variable. However, little is known about why some people recover from disabilities while others keep declining, and how their different function trajectory patterns relate to their psychological well-being. Second, frailty, disease and disability are common and usually irreversible for the elderly. If disability or morbidity is the only parameter used to determine successful aging, the mental health and subjective-well being dimensions for the disabled or frail elderly are neglected. However, through the processes of selection, optimization and compensation (Baltes and Baltes, 1990), disabled elderly people can age successfully by coping with the stress of their disability. In addition, most studies define mortality as the worst outcome of health or the failure of successful aging (Diehr and Patrick, 2003). However, many elderly people have few health problems before they die. In fact, they may enjoy a better quality of life than the disabled elderly who live longer. Living longer does not necessarily mean living better (Hsu, 2005).

The purpose of this study was to examine the effect of physical function trajectories on the emotional health and subjective well-being among the elderly in Taiwan. The research rationales are as follows: first, disability of physical function was viewed as a stressor in later life; emotional health and subjective well-being were defined as the outcome of successful aging as measured by life satisfaction and the absence of depressive symptoms. Second, it was assumed that this type of physical function trajectory showed a special pattern during the follow-up to show the heterogeneity of the elderly. Thus, the trajectory group was defined in a longitudinal way to examine the retrospective dynamic change of emotional health and subjective well-being among different trajectories. Third, death is excluded as an indication of failure of health. Instead, both death and survival were used as outcome statuses and combined with disability to define the physical function trajectory. The research hypotheses tested in this study are:

- (1) Different physical function trajectories have average differences in depressive symptoms and life satisfaction (between-group differences).
- (2) Declining physical function has an effect in reducing emotional health and subjective well-being, i.e. increasing physical function difficulties increases depressive symptoms and reduces life satisfaction (between-individual differences).
- (3) Those who die without disability (died-well) are not significantly different in depressive symptoms and life satisfaction from survivors without disability. The died-well people also show better emotional health

(less depressive symptoms) and better subjective well-being (higher life satisfaction) than the disabled survivors.

## Methods

### Data and samples

Data were obtained from the 'Survey of Health and Living Status of the Elderly in Taiwan', which was a longitudinal survey first conducted in 1989. In the data, face-to-face interviews were conducted with a random sample of individuals (60 or more years old) derived from the entire Taiwanese elderly population, including those in institutions, but most participants lived in the community (99.0%). A three-stage proportional-to-size probability sampling technique was used (see Figure 1). The first stage consisted of a stratified sample of the administrative units (townships); the second consisted of blocks within the selected townships; and the third consisted of two respondents selected systematically from the register in each selected neighborhood. The participants were followed-up in waves. The data used in this study were from the waves in 1993 ( $n = 3155$ ), 1996 ( $n = 2669$ ) and 1999 ( $n = 2310$ ). Physical function variables were unavailable in 1989. The response rate is shown in Figure 1. The death cases were verified through official death registration records. Goodness-of-fit tests of gender and age revealed that death and loss of follow-up cases were older, and more were male than female than in the analysis samples.

### Measures

#### Physical function difficulty and trajectory

Physical function was measured based on activities of daily living (ADL). The items included: eating, dressing, transferring from bed/chair, going to the toilet, taking a bath and walking indoors. The difficulty was measured from no difficulty, a little difficult, very difficult and cannot do it at all (scored 0–3). The total score of six items of ADL ranged from 0 to 18.

It is assumed that the aging process is heterogeneous for the elderly, and thus the change of physical function is assumed to show specific patterns for different kinds of physical disability trajectories. Therefore, the physical disability trajectory was defined by the ADL disability pattern, which was defined according to ADL difficulties in two of the six items, and by the difficulty lasting for more than 3 months. The trajectory was categorized into seven groups: (1) independent – physical function was always independent without any disabilities 1993–1999; (2) declined – no difficulty at the starting point but became disabled later (in 1996 or 1999); (3) disabled – always disabled during 1993–1999; (4) improved – disabled in 1993 but returned to independence later, or independent in 1993, disabled in 1996 but went back to independence in 1999; (5) fluctuating – disabled in 1993

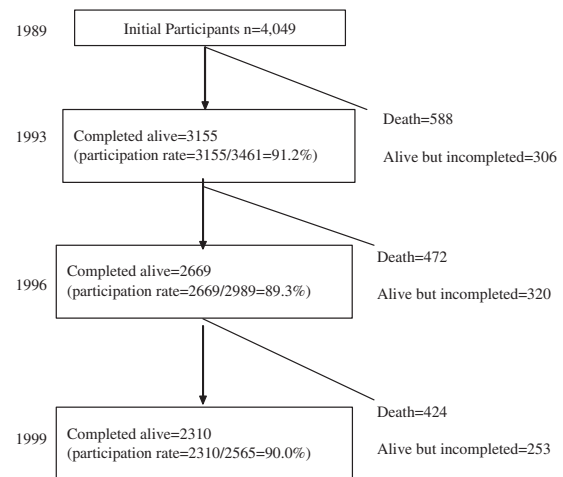


Figure 1. Participants in the study.

and 1999 but independent in 1996, or went from being disabled to independent and then later died; (6) died well – always independent before death between 1993 and 1999; and (7) died disabled – always disabled before death between 1993 and 1999.

### Outcome variables

Emotional health and subjective well-being dimensions of successful aging were used as the dependent variables, which were measured by absence of depressive symptoms and life satisfaction, respectively. Symptoms of depression were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). The original version was a 20-item scale CES-D (Radloff, 1977), which has been proved to show good sensitivity and specificity compared with the diagnoses by the American Psychiatric Association's Diagnostic and Statistics Manual (DSM) criteria. In this study, the 10-item version was applied (Kohout, Berkman, Evans, & Huntley, 1993). Its scale proved to be comparable to other studies and robust over 12 months. Each item was scored from 0 to 3, and the total score ranged from 0 to 30. CESD-10 was also validated by DSM criteria in the elderly population in Taiwan (Tractenberg, Weiner, & Chuang, 2007). The cutoff point for depressive symptoms was determined by converting the point to score of 16 on a 20-item scale (Radloff, 1977). In this study the total CES-D score was mainly applied. The lower score of CES-D showed fewer depressive symptoms, i.e. better emotional health. In this study, the Cronbach's alpha of CES-D in three waves was 0.74, 0.70, and 0.72, respectively.

Life satisfaction measures were from the Life Satisfaction Rating (LSR) (Neugarten, Havighurst, & Tobin, 1961), and the correlation between LSR and clinical rating by clinical psychologists was 0.64. In this study, only four items were available in the 1993 wave, and thus only these four items were used in the analysis: (1) compared with other people, my life is

better than most of them; (2) these are the best years of my life; (3) I expect some interesting and pleasant things to happen to me in the future; and (4) I would say I am satisfied with my way of life. Each item was rated by yes or no (scored 1 or 0); total score ranged from 0 to 4. Cronbach's alphas for the 4 item LSR in 1993, 1996 and 1999 were 0.71, 0.59, and 0.61.

#### *Control variables*

Control variables included cognitive function, social support and demographic variables. Cognitive function was measured with the Short Portable Mental Status Questionnaire (SPMSQ) (Pfeiffer, 1975). The measures included participant's knowledge of location; participant's knowledge of day, month, and year; participant's knowledge of his/her present age; participant's knowledge of the current president and the last president; participant's ability to count backward from 20 by threes; participant's ability to repeat some words or repeat numbers in reverse; and participant's knowledge of his/her mother's maiden name. Normal cognitive functioning or impairment was adjusted for education level according to the rule of interpolation (Wu & Chang, 1997).

Social support was assessed as the giving and taking of emotional support and instrumental support, including four items: (1) satisfaction derived from the emotional care of family/friends; (2) satisfaction with care received when ill and financial support received; (3) family/friends come to consult you concerning problems or worries when needed; and (4) providing help to your family/friends with child care, activities of daily living or establishment of financial or material support. Each variable was scored as 0 or 1, yielding total score ranging from 0 to 4. Next, a score of 4 was defined as high social support; a score of 3 was medium; and a score of 2 or below was low. High or medium social support was viewed as a moderating factor for the physical function trajectory.

Demographic variables included age, gender, education (illiterate, elementary school, primary high school or more), marital status (with or without spouse) and number of chronic diseases (including hypertension, diabetes, heart disease, stroke, respiratory disease, cancer, digestive disease and kidney disease). Education was categorized as illiterate, elementary school and primary high school or more. Table 1 shows the demographic distribution of sample characteristics.

#### *Analysis*

Linear mixed models (LMM) were conducted for analysis by the MIXED procedure in SPSS (SPSS Inc., 2005). LMM handles repeated measures and differentiates fixed effects and random effects of the variables. LMM may handle subjects with unbalanced design (incomplete data or missing in the different waves), because LMM is based on maximum likelihood

(ML) or restricted maximum likelihood (REML) methods for estimation. In addition, in LMM the interaction within-subject or between-subjects may be decided by the interest of the researchers; it also allows various assumptions about the covariance matrix. In this repeated-measure study, there were missing data in the cases due to mortality, data missing or loss of follow-up, and thus LMM is suitable for application.

The outcome variables were depressive symptoms and life satisfaction. The main independent variables were the ADL difficulty score and physical function trajectory. Each dependent variable was analyzed by two models: one model used only the ADL difficulty score and its interaction with age and random effects to interpret any changes in the outcome variables. The other model added physical disability trajectories to examine the differences among the trajectory groups. REML was used for parameter estimation. The  $-2$  log likelihood significantly improved when adding the physical function trajectories. Because the cases in the improved group and the fluctuating group were few, these two groups were combined together in the multivariate analysis.

#### **Results**

Table 1 shows the characteristics of the participants by physical disability trajectories. The participants in the independent group and the died-well group were younger, proportionally more male, more highly educated and with fewer chronic diseases. The change of ADL difficulty shows the pattern of the physical trajectory groups. The independent and died-well group maintained little or no ADL difficulty; the declined group had a greater increase in ADL difficulty, respectively from 0.1 to 7.9, and the change was dramatic from 1996 to 1999. The died-disabled group also had a significant increase from 3.3 to 10.4 from 1993 to 1996. The disabled group maintained their ADL difficulty from 1993 to 1996, but suddenly dropped in 1999, which may indicate the mortality or loss to follow-up of the people in this group. The improved group and the fluctuating group showed an up-and-down trend according to their disability change.

The participants without disability at baseline, i.e. the independent, declined and died-well groups, had fewer depressive symptoms and higher life satisfaction at baseline. The disabled, improved and fluctuating groups had more depressive symptoms and less life satisfaction at baseline. The declined and died-disabled group increased depressive symptoms quickly during follow-up, while the disabled group increased gradually. However, most groups maintained or increased life satisfaction during follow-up except for the declined group.

The repeated multivariate analysis of change in depressive symptoms and life satisfaction by ADL difficulty and physical trajectories is shown in Tables 2 and 3. The interaction terms of physical function

Table 1. Participant characteristics by physical function trajectories.

	Physical disability trajectory categories <sup>a</sup>							
	Total (n = 3155)	Independent (n = 1782)	Decline (n = 189)	Disabled (n = 132)	Improved (n = 48)	Fluctuating (n = 14)	Died well (n = 605)	Died disabled (n = 79)
Age in 1993, mean (SD)	71.4 (5.9)***	69.8 (4.9)	74.0 (6.7)	76.3 (7.2)	70.3 (4.9)	77.2 (7.0)	73.8 (6.3)	75.7 (6.2)
Gender (%)								
Male	56.5***	56.3	46.6	46.2	45.8	21.4	64.3	51.9
Female	43.5	43.7	53.4	53.8	54.2	78.6	35.7	48.1
Education (%)								
Illiterate	49.8***	44.8	60.8	72.7	58.3	85.7	53.1	62.0
Elementary school	32.5	3.1	28.0	19.7	35.4	7.1	32.9	26.6
Primary high school+	17.7	21.0	11.1	7.6	6.3	7.1	14.0	11.4
Marital status (%)								
No spouse	31.0***	26.7	38.1	51.5	18.8	50.0	36.4	41.8
Spouse	69.0	73.3	61.9	48.5	81.3	50.0	63.6	58.2
Number of chronic diseases in 1993, mean (SD)	1.1 (1.1)***	0.9 (1.0)	1.2 (1.1)	2.0 (1.5)	1.6 (1.4)	1.5 (0.9)	1.2 (1.2)	1.5 (1.1)
ADL difficulty, mean (SD)								
1993	0.7 (2.9)***	0.0 (0.1)	0.1 (0.4)	10.8 (6.0)	2.2 (3.7)	5.4 (4.5)	0.0 (0.3)	3.3 (5.6)
1996	0.8 (3.0)***	0.0 (0.2)	2.5 (4.6)	10.8 (5.5)	3.9 (4.0)	0.5 (0.8)	0.5 (2.9)	10.4 (6.0)
1999	1.0 (3.3)***	0.2 (1.3)	7.9 (6.2)	5.3 (7.3)	1.2 (3.3)	4.6 (5.1)	—	—
Cognitive function: intact (%)								
1993	87.4***	92.1	81.7	41.7	88.6	60.0	83.9	59.1
1996	81.4***	85.7	68.4	3.8	66.7	37.5	78.5	19.1
1999	83.6***	85.1	61.7	100.0	65.5	66.7	—	—
Social support: good (%)								
1993	73.5***	80.4	58.8	33.3	59.1	54.5	64.4	53.2
1996	69.0***	73.2	49.7	30.0	43.6	70.0	62.9	21.9
1999	59.8***	62.3	34.6	11.1	36.8	12.5	—	—
Depressive symptoms, mean (SD)								
1993	6.8 (6.0)***	5.9 (5.3)	8.2 (6.0)	14.4 (8.0)	13.1 (7.7)	14.1 (4.9)	7.4 (6.3)	9.2 (6.7)
1996	6.5 (6.4)***	5.8 (5.8)	9.2 (7.9)	15.2 (8.1)	13.6 (7.6)	9.4 (7.9)	7.6 (6.6)	14.2 (8.2)
1999	6.3 (6.5)***	5.7 (6.0)	12.5 (7.6)	16.4 (9.5)	12.5 (7.9)	13.5 (9.5)	—	—
Life satisfaction, mean (SD)								
1993	2.3 (1.4)***	2.4 (1.4)	2.3 (1.5)	1.2 (1.4)	1.4 (1.5)	1.4 (1.4)	2.1 (1.4)	1.8 (1.4)
1996	2.5 (1.3)***	2.6 (1.3)	2.2 (1.3)	1.0 (0.7)	1.5 (1.3)	2.1 (1.5)	2.4 (1.3)	1.8 (1.4)
1999	2.5 (1.3)***	2.6 (1.3)	1.6 (1.3)	1.3 (1.1)	1.7 (1.3)	1.8 (1.4)	—	—

Note 1: The differences among trajectory groups across the baseline characteristics were examined by chi-square test, *t*-test and one-way ANOVA. \*\*\**p* < 0.001. <sup>a</sup>Variables with missing data were casewise deleted.

Note 2: Physical function trajectory groups are defined: (1) independent – physical function was always independent without any disabilities in 1993–1999; (2) declined – no difficulty at the starting point but became disabled later (in 1996 or 1999); (3) disabled – always disabled in 1993–1999; (4) improved – disabled in 1993 but returned to independent later, or independent in 1993, disabled in 1996 but went back to being independent in 1999; (5) fluctuating – disabled in 1993 and 1999 but independent in 1996, or went from disabled to independent and then later died; (6) died well – always independent before death between 1993 and 1999; and (7) died disabled – always disabled before death between 1993 and 1999.

Note 3: The repeated measured variables in three waves included depressive symptoms, life satisfaction, ADL difficulty, cognitive function and social support; age was time-dependent. The other variables were measured according to baseline data.

Note 4: *Post-hoc* comparison of ADL difficulty differences among the trajectory groups by Scheffe's test in three waves, and the significant differences included: (1) 1993 – independent differed from disabled, improved, fluctuated and died disabled; declined differed from disabled, improved, fluctuated and died disabled; disabled differed from improved, fluctuated, died well, and died disabled; improved differed from fluctuated and died well; fluctuated differed from died well and died disabled; and died well differed from died disabled. (2) 1996 – independent differed from declined, disabled, improved, died well and died disabled; declined differed from disabled, improved, died well, and died disabled; disabled differed from improved, fluctuated and died well; improved differed from fluctuated, died well and died disabled; fluctuated differed from died disabled; and died well differed from died disabled. (3) 1999 – independent differed from declined, disabled and fluctuated; declined differed from disabled, improved and fluctuated; disabled differed from improved; and improved differed from fluctuated.

trajectories and ADL difficulty and the interaction of age and ADL difficulty, and the age squared terms were also added to the models, but they were not significant so were later removed.

Table 2 shows the results of linear mixed models for the change in depressive symptoms by ADL difficulty and physical function trajectories. ADL difficulty was

significantly related to an increase of depressive symptoms, in both fixed effect and random effect. When adding physical function trajectories in the analysis (model 2), the declined, disabled, improved and fluctuating, died-well and died-disabled groups all had significantly more depressive symptoms than the independent group. In addition, there were changes of

Table 2. Repeated multivariate analysis of change in depressive symptoms, ADL difficulty, and physical function trajectories by linear mixed models.

Variables	Depressive symptoms coefficient (SE)	
	Model 1	Model 2
<i>Fixed effect</i>		
Intercept	5.565 (1.070)***	5.444 (1.102)***
ADL difficulty	1.816 (0.761)*	1.620 (0.768)*
Physical function trajectories		
Declined	—	1.634 (0.371)***
Disabled	—	2.368 (1.048)*
Improved and fluctuating	—	4.350 (0.633)***
Died well	—	1.268 (0.243)***
Died disabled	—	1.778 (0.722)*
Age	-0.032 (0.015)*	-0.035 (0.015)*
Age × ADL difficulty	-0.015 (0.010)	-0.014 (0.010)
Cognitive function (impaired)	1.093 (0.205)***	-0.978 (0.210)***
Social support (poor)	1.959 (0.149)***	1.923 (0.153)***
Chronic disease numbers	0.979 (0.076)***	0.873 (0.080)***
Sex (female)	0.977 (0.188)***	1.031 (0.196)***
Education: illiterate	1.523 (0.242)***	1.570 (0.252)***
Education: elementary school	0.430 (0.233)	0.496 (0.242)*
Marital status (without spouse)	-0.247 (0.193)	0.150 (0.200)
<i>Random effect</i>		
ADL difficulty	0.364 (0.098)***	0.334 (0.097)**
Age	0.002 (0.0001)***	0.002 (0.0001)***
Residual errors	21.225 (0.491)***	21.103 (0.500)
-2 LL	42808.215 (d.f. = 18)	39841.082 (d.f. = 24)
AIC	42814.215	39847.082
BIC	42834.716	39867.374

Note 1: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . Only survivors were included in the analysis. -2LL: -2 restricted log likelihood; AIC, Akaike's Information Criterion; BIC, Schwarz's Bayesian criterion.

Note 2: Physical function trajectory groups are defined as in Table 1.

Note 3: The repeated measured variables in three waves included depressive symptoms, life satisfaction, ADL difficulty, cognitive function and social support; age was time-dependent. The other variables were measured according to baseline data. Depressive symptom score ranged from 0 to 30; the higher score means the more depressive symptoms. ADL score ranged from 0 to 18; the higher score means greater difficulty in ADL. The reference groups for the linear regression analysis are: physical function trajectory (independent), cognitive function (intact), social support (good), sex (male), education level (primary high school or more) and marital status (with spouse).

ADL difficulty within the declined, disabled, improved and fluctuating, and died-disabled groups (see Table 1). Since ADL difficulty was significantly related to the increase of depressive symptoms, it means that these trajectory groups increased the change in depressive symptoms accompanied by their change in physical function. For example, the declined group had an increase in ADL difficulties, averaging from 0.1 to 7.9 in 1993–1999. The span of depressive symptoms increased from 0.1 to 12.9. For the died-disabled group, their ADL difficulty increased from 3.3 to 10.4 in 1993–1996. Their depressive symptoms increase span ranged from 5.9 to 18.5. This indicates that the declined group had potential problem of having depressive symptoms. For the died-disabled group, who already had depressive symptoms at baseline (score of 9.2), they became dramatically more severe and accompanied by more disabilities before they died. In the same way, although the improved and fluctuating group had on average higher depressive symptoms than the independent group, their

depressive symptoms changed accompanied by their change in physical function status. The died-well group showed significantly more depressive symptoms than the independent group but the coefficient (1.268) was the lowest compared with other trajectory groups. However, ADL difficulty only increased by 0.5 on average, which increased the depressive symptoms only a little, and thus the depressive symptoms for the died-well group showed lower depressive symptoms than other trajectories.

The elderly who were female, illiterate, had impaired cognitive function, poor social support and more chronic diseases had more depressive symptoms. Marital status was not significantly related to depressive symptoms.

Table 3 shows the association of change in life satisfaction, ADL difficulty and physical function trajectories. In model 1, ADL difficulty significantly reduced life satisfaction (coefficient = -0.242). The interaction of ADL difficulty and depressive symptoms offset a little of the reducing effect on life satisfaction

Table 3. Repeated multivariate analysis of life satisfaction with physical function trajectories and covariates by linear mixed models.

Variables	Life satisfaction coefficient (SE)	
	Model 1	Model 2
<i>Fixed effect</i>		
Intercept	1.864 (0.214)***	1.871 (0.222)***
ADL difficulty	-0.242 (0.112)*	-0.199 (1.117)
Physical function trajectories		
Declined	—	0.036 (0.071)
Disabled	—	-0.321 (0.182)
Improved and fluctuating	—	-0.254 (0.119)*
Died well	—	-0.106 (0.048)*
Died disabled	—	-0.203 (0.139)
Age	0.020 (0.003)***	0.021 (0.003)***
Age × ADL difficulty	0.003 (0.001)	0.002 (0.001)
Depressive symptoms	-0.088 (0.003)***	-0.086 (0.003)***
ADL difficulty × depressive symptoms	0.003 (0.001)*	0.003 (0.001)*
Cognitive function (impaired)	-0.115 (0.043)**	-0.098 (0.044)*
Social support (poor)	-0.320 (0.032)***	0.320 (0.033)***
Chronic disease numbers	-0.049 (0.015)**	-0.033 (0.015)*
Sex (female)	0.205 (0.036)***	0.186 (0.037)***
Education: illiterate	-0.355 (0.046)***	-0.370 (0.048)***
Education: elementary school	-0.171 (0.044)***	-0.184 (0.046)***
Marital status (without spouse)	-0.232 (0.037)***	-0.209 (0.038)***
<i>Random effect</i>		
ADL difficulty	0.001 (0.001)	0.001 (0.001)
Age	$4.40 \times 10^{-5}$ ( $4.10 \times 10^{-6}$ )***	$4.04 \times 10^{-5}$ ( $4.14 \times 10^{-6}$ )***
Residual	1.117 (0.254)***	1.105 (0.026)***
-2 LL	21298.234 (d.f. = 20)	19847.479 (d.f. = 26)
AIC	21304.234	19853.479
BIC	21324.716	19873.754

Note 1: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . Only survivors were included in the analysis. -2LL: -2 restricted log likelihood; AIC: Akaike's Information Criterion; BIC: Schwarz's Bayesian criterion.

Note 2: Physical function trajectory groups are defined as in Table 1.

Note 3: The variables which were time-dependent and repeated measured in three waves included age, ADL difficulty, cognitive function and social support. Depressive symptom score ranged from 0 to 30; the higher score means more depressive symptoms. Life satisfaction score ranged from 0 to 4; the higher score means a better life satisfaction. ADL score ranged from 0 to 18; the higher score means more difficulty in ADL. The reference groups for the linear regression analysis are: physical function trajectory (independent), cognitive function (intact), social support (good), sex (male), education level (primary high school or more) and marital status (with spouse).

(coefficient = 0.003). In model 2, ADL difficulty reduced life satisfaction (coefficient = -0.199), although the coefficient was not significant. Among the trajectory groups, the improved and fluctuating group and the died-well group showed a lower life satisfaction than the independent group. Other trajectory groups did not show significant differences. For the physical changing trajectory groups (the declined, disabled, improved and fluctuating, and died-disabled groups), increasing ADL difficulty lowered their life satisfaction. The declined group had a non-significant higher life satisfaction than the independent group, but when increasing every ADL difficulty score, the life satisfaction score was reduced. The died-well group had a lower life satisfaction than the independent group, but the difference between the died-well and independent group was lessened by comparing the coefficient of the disabled group or died-disabled group. Since the died-well group only increased ADL difficulty from 0.0 to 0.5, the reduction of life satisfaction was limited.

Advancing age increased life satisfaction (coefficient = 0.020), which means that life satisfaction increases when getting older. More depressive symptoms lower life satisfaction. The elderly whose cognitive function was impaired, had poor social support and more chronic disease, were male, had less education and were without a spouse had lower life satisfaction. It is noticeable that the social support and demographic variables had equal or even larger effects than increasing ADL difficulty on the change in life satisfaction.

## Discussion

This study explored the change of emotional health and subjective well-being by physical function difficulty and trajectories. We viewed the physical function difficulty and disability as stresses in life and having an impact on depressive symptoms and life satisfaction. The results with respect to the three research hypotheses were as follows: (1) depressive symptoms and life satisfaction showed differences among the physical

trajectory groups; (2) increasing physical function difficulties increased depressive symptoms and reduced life satisfaction; and (3) the died-well group showed a difference from the independent group in depressive symptoms and life satisfaction, but those who died without disability did have better emotional health and subjective well-being than the disabled survivors.

The disability and the change of function difficulty reflected depressive symptoms significantly. This finding is consistent with results from previous studies (Bruce, et al., 1994; Harris et al., 2003, 2006; Prince et al., 1998; Wada et al., 2004; Zeiss et al., 1996). Significant differences in depressive symptoms were found between the independent group and all the other groups. Furthermore, for those groups whose disability increased over time (i.e. the declined, disabled, improved and fluctuating and died-disabled groups), their depressive symptoms increased concurrently with their physical disabilities. This indicates that the health risks for these trajectory groups were not only physical but also emotional. Similar results were reported by Zeiss et al. (1996). In that study the survival time after the onset of depressive symptoms for non-impaired, median-impaired and highly-impaired elderly was 38.0, 41.9 and 43.0 months, and the survival curve reached a stable level after 36 months. This suggests that coping with physical disability stress is related to emotional health. However, some questions arise. Is physical difficulty reversible? Would depressive symptoms be reduced following recovery from a disability? The results showed that the improved and fluctuating group had a higher score in depressive symptoms than the independent group. In this study the improved group and fluctuating group were combined in the multivariate analysis due to limited cases. Nevertheless, the mean of depressive symptoms changed with ADL difficulty in these two groups (see Table 1). That indicates the possibility of recovery from disability for some people.

If disabled people can cope successfully with disabilities and try to prevent further disability or even improve from disability, their emotional health could possibly improve too. However, who has the chance to recover from disability? The results in Table 1 also indicate that the participants in the independent group and the died-well group were younger, proportionally more female, had higher education, with less chronic disease and a greater proportion of good social support and intact cognitive function. The improved group was more often female, had a greater tendency to have a spouse, a greater proportion of good social support and intact cognitive function. The mechanism is unknown yet from this study. Further studies should be conducted to explore the factors that help the elderly improve or recover their physical function from disability.

ADL difficulty was found to reduce life satisfaction, but it was not significant when considering the physical function trajectories. The improved and fluctuating group and the died-well group showed

a lower life satisfaction than the independent group, but no significant difference was found in other groups. Other factors may be more important for life satisfaction than changes in physical disability, such as marital status and social support.

Social support was found to have a moderating effect on depressive symptoms and life satisfaction according to the results. Actually, social support has been found to have a mediating (Newsom and Schulz, 1996) and moderating effect on depressive symptoms (Chi and Chou, 2001; Harris et al., 2003; Jang et al., 2002; Prince et al., 1997). Pearlin and Skaff (1996) also illustrated that a successful aging outcome depended on certain moderating resources, such as coping repertoires, social support and mastery. If physical function decline or disability is unavoidable or irreversible for certain older people, their life satisfaction is not necessarily impacted by this stress if their social support is strong. The role of social support in moderating successful aging outcomes for disabled elderly is suggested for further study.

The elderly who maintained independence before they died (the died-well group) had more depressive symptoms and less life satisfaction than the independent group. Although ADL difficulty might be the stressor causing more depressive symptoms and reducing life satisfaction, the died-well group still maintained their independence in ADL function. Therefore, their emotional health and subjective well-being was stable over time. Significant increases in ADL difficulty among the trajectory groups influence their depressive symptoms and life satisfaction; therefore the died-well group seemed to enjoy better emotional health and subjective well-being than the other groups with disabilities. This finding means that, to define death as the worst health outcome, as has been done in previous studies, might be wrong. Especially when mental health is the main concern, mortality may be not the worst outcome. If the elderly maintain good physical, mental and social health before death, then there is no reason to view them as failures in successful aging. Unfortunately, we were only able to observe the health of those who died during a short period of time in this study. A longer pattern of health for the died-well elderly compared with other groups should be studied.

This study had some limitations. First, the duration of the follow-up was limited and only three points were available to observe the physical function trajectory. Thus, the ability to detect dynamic change in the disability trajectories was limited, especially the observation duration for the death cases. Second, we may not have considered some confounders in the model, such as loss-related events or major life events that occurred in youth or in the recent past. The life-course risk factors for depressive symptoms or life satisfaction also were not analyzed in this study. Third, the patterns for the improved and fluctuating participants were unable to differentiate in the analysis due to the limited number of cases.



This study found a significant influence of physical function trajectory on emotional health, and a moderate effect on life satisfaction in certain trajectories. When people maintain normal physical function before death, they can have better emotional health and life satisfaction than those who survive but are disabled. This means that longevity should not be the only criterion for successful aging. In addition, even some disabled elderly may still enjoy subjective well-being regardless of whether they are disabled or have functional difficulty. It was also found that some moderating factors might help successful aging when encountering disability in later life, such as social support. Baltes and Baltes (1990) proposed the 'selection, optimization, with compensation' model, i.e., that aging is a normal and dynamic process that involves losses and gains. Through the processes of selection, optimization and compensation, elderly individuals who encounter disability or reduced ability in certain tasks in their life can still achieve successful aging if they select realistic domains that can be maintained and enhance their functioning and adaptation in these selected life domains. It is suggested that future studies should be conducted on the how coping strategies and support resources can help the disabled elderly improve successful aging. Health policy should focus not only on physical health for the elderly, but also on how to help the disabled elderly to improve their mental health and subjective well-being.

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