Frailty, Socioeconomic Factors, and Life Satisfaction of the Elderly

Yuan-Ho Hsu[1], Ph.D.[1] & Chih-Hsing Wu[2,3], M.D.[2,3]

Abstract

This paper investigates the factors affecting the life satisfaction of the elderly in an aging community. This study uses the data collected by the authors from a field study. The dataset contains biological, socio-economic, physical health, and psychological information of senior residents aged 65 and over in a community in southern Taiwan. The empirical results from cross-sectional ordinal logistic regression indicate that frailty or age-related chronic diseases that impair the elders' physical function have a significant adverse impact on life satisfaction. Besides, the occurrence of a cerebral vascular accident that leads to claudication has a significant negative impact on elders' life satisfaction. Moreover, elders' perceived income sufficiency and social support correlate positively with life satisfaction. Economic or social welfare policies that improve the economic security of the elderly and public health policies that delay or prevent the development of frailty can upgrade the life satisfaction of the elderly.

Keywords: Life Satisfaction, Frailty, Elderly, Logistic Regression Model

1. Introduction

Population aging is a global phenomenon in the 21st Century. The United Nations (2015) predicts that the world's population aged 60 and over will grow by 65% between 2015 and 2030, from 901 million to more than 1.4 million. The United Nations had predicted that almost all countries would experience substantial growth in the numbers of old aged persons in 2015-2030, with that the developing regions will have a faster pace in aging.[4] The pace of population aging in Taiwan has accelerated in the past two decades. Taiwan has phased into an "aging economy" in 1993 and an "aged economy" in 2018.[5] According to the official population projection, Taiwan will become a "super-aged economy" in 2026.[6]

Population aging is an unavoidable and irreversible demographic dynamic for the decades to come. The welfare of the elderly would be an important policy issue with the evolution of this demographic development. Level of subjective life satisfaction or happiness is a proxy used for the measurement of welfare. Much research has investigated the predictors of happiness in general, yet there is not much study focus on factors affecting the happiness of the elderly.

---

[1] Professor, Department of Economics, College of Social Science, National Cheng Kung University, Tainan City, Taiwan. Address: 1 University Rd., Tainan

[2] M.D., Department of Family Medicine, National Cheng Kung University Hospital, Tainan City, Taiwan.

[3] Associate Professor, Institute of Gerontology / Institute of Behavior Medicine, National Cheng Kung University Medical College, Tainan City, Taiwan.

[4] United Nations (2015). *World Population Aging Highlights*, p.1.

[5] An economy is referred as "aging economy" if the ratio of aged persons (persons with age 65 and over) to total population in this economy reaches 7%; when the same ratio reaches 14% and 20% it is referred as "aged economy" and "super aged economy" respectively.

[6] See National Development Council, *Population Projections for the R.O.C. (Taiwan): 2018~2065*. [Online] Available https://pop-proj.ndc.gov.tw/main_en/dataSearch.aspx?uid=78&pid=78.

Some studies on life satisfaction of the elderly focused on subjects in a nursing home or under institutional placement; there are few studies investigates the elderly living in the community. Life satisfaction in aging and aged society is an important topic that needs to be further studied.

This paper tries to contribute to the study of happiness in an aging society, by investigating factors associated with the life satisfaction of the elderly residing in a community. Conventional studies used to investigate the association of life satisfaction with various socio-economic factors, such as gender, age, marital status, education attainment, self-rated health, social network, and social support, family members, and financial strain (e.g. Layard (2005); Frey, B. and A. Stutzer (2002)). The current paper endeavors to incorporate health information and physical frailty as predictors of life satisfaction.

This study uses data collected from a survey by face-to-face interviews and medical examinations. In the survey questionnaire, we asked the respondents to indicate their subjective life satisfaction in scales. With the primary data collected, this study applies cross-sectional data analysis to investigate a broad set of factors that are possible determinants of life satisfaction of the elderly. The set of variables considered in this study includes demographic and socio-economic factors, physical health condition, subjectively perceived health, and perceived quality of family and social supports.

The organization of this paper is as follows: Section 2 presents a review of the literature of previous studies on frailty and life satisfaction of the elderly. Section 3 explains the data and the method used in this study. Section 4 illustrates the setup of the empirical model for this study. Section 5 presents the empirical results of this study and explores the probability of changes in life satisfaction given the changes in some specific predictors. Section 6 summarizes the results of this study and discusses policy implications to promote the life satisfaction of the elderly.

2. Literature Reviews

This section of the literature review consists of two parts. The first part reviews literature on the notion of frailty and the second part surveys the notion of "happiness" and discusses plausible index of happiness.

Frailty is a prevalent syndrome in old age and is associated with disability, comorbidity, hospitalization, and mortality. Fried *et al.* (2001) developed a comprehensive definition of frailty, which states that "Frailty was defined as a clinical syndrome in which three or more of the following criteria were present: unintentional weight loss (10 lbs in past year), self-reported exhaustion, weakness (grip strength), slow walking speed, and low physical activity." Other studies, such as Avila-Funes *et al.* (2008), defined frailty as having at least three of the following criteria: weight loss, weakness, exhaustion, slowness, and low activity. Avila-Funes *et al.* (2008) used multiple covariates method to test the predictive validity of frailty on incident disability, hospitalization, and death.

Abu-Bader et al. (2002) bridged the correlation of physical frailty in elderly and life satisfaction and examined the relationship between life satisfaction and various factors, including physical status, emotional health, social support and locus of control in the frail elderly. The empirical results of this study indicate that physical health is the most significant predictor of life satisfaction. Gerdtham and Johannesson (1997) analyzed the relationship between happiness and health status based on a sample of 5,000 individuals in the Swedish adult population. In this study, they found a positive and statistically significant positive relationship between higher health status and happiness.

However, life satisfaction or happiness is a notion that is not easy to define or measure. In the economics literature, there are several ways to define happiness indicators.[7] Various economic studies have explored the relationships between happiness and specific variables. In particular, some scholars have devoted a good amount of effort trying to assess the relationship between income and happiness. Argyle (2002) provides a good summary of the "income and happiness" relationships and obtains contradictory results. For example, he observes that rising incomes have not affected life satisfaction and that winning lottery has negative effects for some. Besides, he finds that the rich are not always happier than the average people. Argyle also observes that, on the individual level, the very poor are less happy; however, on the macro-level, the richer countries have higher levels of reported happiness than poorer countries.

---

[7] See Layard, 2005 or Argyle, 2002 for a reflective summary.

Another large body of research on happiness in economics takes reported subjective well-being as a proxy measure for utility. Halvac (2011) examined the association between subjective life satisfaction and two kinds of individual-level characteristics: demographics (age, gender, foreign-born and marital status) and socio-economic (education, monthly household income, employment, and student status). The study found that the economic variables, employed status, and higher household income are associated with greater subjective life satisfaction. Kapteyn et al. (2009) used reported survey data to examine life satisfaction in the U.S. and the Netherlands. They concluded that global life satisfaction of happiness is well-described by four domains: job or daily activities, social contacts and family, health, and income. Contrary to the conclusion of Halvac (2011), they concluded that economic factor, such as income, has the least impact on life satisfaction, whereas social contacts and family support have the highest impact on global life satisfaction, followed by job and daily activities and health.

With the recent global demographic aging, there are more studies investigates the life satisfaction of the elderly in particular. Chou and Chi (1999) tried to identify the predictive variables of life satisfaction in Chinese elderly people based on longitudinal data of Hong Kong. This study concluded that younger elderly persons with less financial strain, better social support, fewer somatic complaints, and more education reported a higher level of life satisfaction three years later.

Concerning the measurement or revelation of personal wellbeing or happiness, recent development in this study employs subjective life satisfaction index as a proxy for life satisfaction study. Dienier (1985) discussed the development and validation of a global life satisfaction index, the "Satisfaction with Life Scale" (SWLS). It is maintained that the SWLS has favorable psychometric properties and correlation with measures of subjective well-being; moreover, it correlates predictably with specific personality characteristics. Kahneman and Krueger (2006) discussed subjective well-being from economist's viewpoint and maintained that, while various measures of well-being are useful for some purposes, it is important to recognize that subjective well-being measures features of individuals' perceptions of their experiences, not their utility as economists typically conceive of it. Various recent studies had used this kind of subjective well-being indicator in the empirical studies (see, for example, Tiefenbach and Kohlbacher (2013), Mhaolain et al. (2012), Pinquart (2001)); some others explored the subjective well-being and its economic correlates (Layard (2005), Clark, Frijters and Shields (2008)).

3. Data and Method

This study uses cross-sectional survey data collected from the Tian-Liao district (TLD), Kaohsiung in 2012. The survey applies a whole-district random sampling method to collect data from 1,966 elderly community residents. After excluding the empty houses, death, non-ambulation, and refusal, 549 senior residents aged 65 years old and over participated in the study (response rate=50%) were surveyed. This survey conducted a face-to-face interview with structured questionnaires to collect essential information on each subject. The collected information includes demographic, socio-economic, lifestyle, medical history, and physical activity based on the International Physical Activity Questionnaire (IPAQ) of each subject. After dropping off some incomplete answered respondents, there were 489 valid subjects for this analysis. The response rate of this survey is 50%. Figure 1 illustrates the sampling process of the survey.
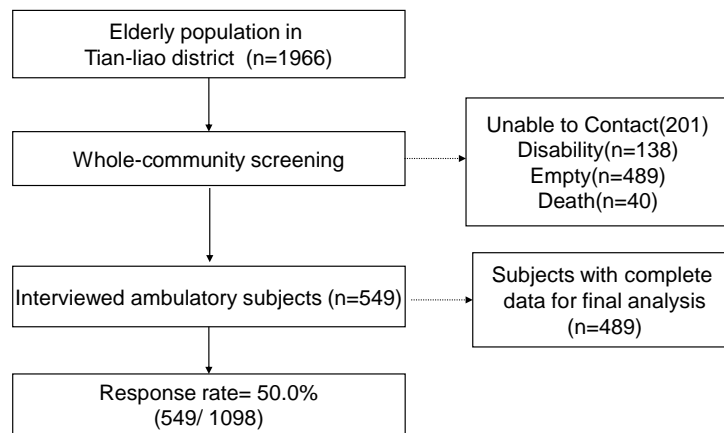
Figure 1: Sampling Process
Source: Wu CH, et al. *Geriatrics & Gerontology International* 2014:14: 69-75

Various survey-based happiness studies asked the question: "How satisfied are you with your life?" In our work, we follow this approach and define "happiness" as satisfaction with life in general. We ask the respondents "How does *x* affect happiness?" where *x* can be income, health, marital status, or any other possible predictor of happiness. We also ask the respondents to indicate their subjective life satisfaction in 4-scale, ranging from highly satisfied, satisfied, unsatisfied, to highly unsatisfied.

One of our contributions to the current life satisfaction study is that we link physical frailty with the elders' life satisfaction. Physical frailty is a process in which multiple organ systems deteriorate. Frailty leads to physical inactivity and longer periods of disability after an illness. All of these would affect a person's life satisfaction. An elder is frail if he meets three or more of the following five criteria (Fried 2001), namely, unintentional weight loss (10 lbs in the past year), self-reported exhaustion, weakness (grip strength), slow walking speed, and low physical activity. Based on the examination scores collected in the survey, this research classifies the elder's health condition as non-frail, pre-frail, and frail.

4. Empirical Model

The empirical model for this study is as followings

$$LSF_i = F(D_i, O_i, H_i), \qquad\qquad (1)$$

Where LSF_i is the subjective life satisfaction of the surveyor *i*. This study tries to relate an elder's subjective life satisfaction with three categories of predictors: demographic factors (D_i), socio-economic factors (O_i), and health-related factors (H_i). The set demographic factors for this study are age, gender, social-economic status. The socio-economic factors we considered for this study includes economic income in various form, tangible wealth, social connections, and family support. Health-related factors for this study are frailty, old-age related chronic illness, and functional impairment (cerebral vascular accident). We also add some self-rated variables of income sufficiency (or financial strain), self-rated health conditions, and self-rated quality of family and social support. We use the software package STATA for the empirical estimation

5. Results and Discussion

The empirical work in this study first conducts an ordered logistic regression of subjective life satisfaction (LSF) on the set of demographic, socio-economic variables and self-rated variables. Column (1) in Table 1 reports the estimates of this baseline model, Model 1. It indicates that gender, income strain, income support from own children, self-rated quality of family and social support, and moods or psychological conditions are significant predictors of LSF

of the elderly at 5% significant level. In addition to the basic socioeconomics information related to correspondents' daily life, we then extend the baseline model to add physical health information to the set of predictors. Column (2) of Table 1 reports these regression results of the extended model, Model 2.

In the extended model, those significant variables in the previous stage are still statistically significant and two more health-related variables, physical frailty and cerebral vascular accident (CVAHX), are significant at a 5% significance level. The extended model has a Wald statistic $\chi^2(21) = 102.13$ with a p-value of 0.000, which indicates that the model as a whole is statistically significant. A nested model test to test whether Model 1 nested within Model 2 has a test statistic $\chi^2(6) = 14.54$ so that we conclude Model 2 is the full model. For the definition of variables used in this study, please refer to Table 1a for exploration. One of the assumptions underlying ordinal logistic regression is the so-called proportional odds assumption or the parallel regression assumption; that is, the estimated coefficients that describe the odds of being in the lowest category vs. all higher categories of the response variable are the same. If not, the ordinal logistic regression results would not be reliable. A Brant test of parallel regression assumption of Model 2 has a statistic of $\chi^2(42) = 37.63$ with p-value = 0.663, which indicates that we did not violate the proportional odds assumption. We conclude that our extended model is a statistically acceptable model for predicting subjective life satisfaction. (*Can you make an arrangement to make "no-split" in Table 1 & Table 2?)

Table 1: Predictors of Subjective Life Satisfaction (LSF)

Variables	(1) Base Model	(2) Base Model w/Health Info
ages	-0.0639	-0.120
	(0.110)	(0.114)
sex	-0.511**	-0.512**
	(0.240)	(0.245)
sesa	0.187	0.347
	(0.541)	(0.530)
wea	-0.200	-0.264
	(0.221)	(0.225)
slef_rated_health	0.0886	0.125
	(0.171)	(0.182)
income_strain	1.034***	1.063***
	(0.335)	(0.335)
ECO1	-0.144	-0.0976
	(0.227)	(0.232)
ECO2	-0.412	-0.561*
	(0.273)	(0.288)
ECO3	-0.585***	-0.634***
	(0.205)	(0.206)
socwf	-0.298	-0.295
	(0.214)	(0.220)
live_offspring	-0.0361	-0.0716
	(0.198)	(0.201)
hb8012a	-0.0848	-0.135
	(0.230)	(0.237)
self_fass	0.484***	0.440***
	(0.153)	(0.154)
Mood_7days	0.968***	0.982***
	(0.148)	(0.152)
mdrds		0.222
		(0.233)
mnats		0.0988
		(0.289)
CVAHX		1.558***
		(0.487)
HTHX		-0.0237
		(0.204)
DMHX		-0.493*
		(0.298)
HLHX		-0.222
		(0.268)
FRAIL		0.335**
		(0.146)
cut1	1.845	2.236*
	(1.136)	(1.167)
cut2	5.726***	6.208***
	(1.176)	(1.202)
cut3	7.025***	7.519***
	(1.206)	(1.227)
Observations	489	489

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 1a: Variable Definitions and Codes

Variables	Variable Definition	Codes
LSF	Subjective life satisfaction	1) Highly unsatisfied 2) Not satisfied 3) Satisfied 4) Highly satisfied
ages	Age by group	1) age65-69, 2) age70-74 3) age75-79, 4) age80&over
sex	gender	1)male 2)female
sesa	Social-economic status (based on Modified Hollingshead's Index of Social Position, MHISA)	Low (MHISA < 3) High (MHISA >=4)
wea	Has own savings or real assets	0) No 1)Yes
self_rated_health	Self-rated health condition	1) Bad 2) Fair 3) Good or very good
income_strain	Do you have sufficient income for your current daily expenses?	1) Not sufficient or far from sufficient 2) Sufficient or more than sufficient
ECO1	Income source: business income	0) No 1) Yes
ECO2	Income source: Spouse's income	0) No 1) Yes
ECO3	Income source: income from off-springs	0) No 1) Yes
socwf	Major income source: government subsidy or welfare income	0) No 1) Yes
live_offspring	Living with own off-springs	0) No 1) Yes
hb8012a	Family member(s) accompany the respondent to pay a hospital/clinic visit	0) No 1) Yes
self_fass	In general, are you satisfied with the concerns or psychological supports from your family or friends?	1) Not supportive 2) Supportive 3) Highly supportive
Mood_7days	Depressed or in low mood in the past 7 days	Never Sometimes Quite often (more than 3 days)
mdrds	Abnormal kidney condition	0) No 1)Yes
mnats	Malnutrition	1) MNATS12 < 24, have malnutrition 2) MNATS12 >= 24, normal
CVAHX	Cerebral vascular accident	0) No 1)Yes
HTHX	Hypertension	0) No 1)Yes
DMHX	Diabetes mellitus	0) No 1)Yes
HLHX	Hyperlipidemia	0) No 1)Yes
FRAIL	Physical frailty	Non-frail Pre-frail Frail

The empirical results indicate that some socioeconomic predictors such as self-rated income sufficiency (income_strain), gender difference (sex), living with income from off-springs (ECO3), self-rated quality of family and social support (self_fass), psychological condition in the past seven days (Mood_7days) are statistically significant predictors of LSF for the elderly. Besides, physical health conditions that impair daily life activity, such as frailty (FRAIL) and cerebral vascular accident (CVAHX), are significant predictors of adverse life satisfaction of the elderly.

The current study finds a significantly negative association between frailty and subjective life satisfaction. In addition to frailty, a cerebral vascular accident (CVAHX) causes neurological defects, or hypoxia, or ischemia in the brain. The aftereffect of the CVAHX may lead to immobility or partial paralysis. People who recover from CVAHX may also need long-term rehabilitation. All these aftereffects impair the patients' quality of life. Regarding the socioeconomic factors, the empirical results show that, in the community surveyed, the old male is happier than the old female. Also, the elderly who live without income strain tend to report higher life satisfaction than those who live with; those who are financially independent of the support from their offsprings would feel better than those relying on offsprings' income. Moreover, the sensation of being loved or being attended makes people happy. As a result, a good family and social support are important for the elders' subjective life satisfaction.

Some other interesting predictors of life satisfaction, though not statistically significant at a 5% significance level, still worth mention. The elders who have a spouse's income (ECO2) as an extra income source may improve his/her life satisfaction. But the effect is only significant at a 10% significance level. This result, together with the effect of income support from offsprings, indicates that financial sufficiency is important for the subjective life satisfaction of the elderly.

For health-related factors, the empirical results indicate that persons who suffer from diabetes mellitus (DMHX) tend to report a lower level of life satisfaction, though the negative effect is only significant at a 10% significance level. A diagnosed diabetes mellitus patient may have inconvenient in daily life, which includes chronic diet control and/or regular insulin injection. These inconveniences make the patient frustrated so that to report a lower level of life satisfaction.

Some studies show that there is a negative association between high-blood-pressure problems and life satisfaction (Blanchflower and Oswald, 2008). However, the empirical results of the current study indicate that persons with three-hyper tend to have higher life satisfaction, though the effects are not statistically significant. This result could be the outcome of the current universal health insurance program (UHI) in Taiwan. With a UHI coverage rate of 99.6% and well established and accessible district health care system, the UHI has taken good care of the elderly with these three-hyper illnesses in Taiwan. Moreover, UHI pays most of the doctor bills and prescription medicine costs. Low copayment makes it financially affordable for the elderly to visit doctors, which mitigates their worries about the illness. Moreover, a regular visit to the doctor's office also provides the elderly with an opportunity to make a social connection and personal communication with others. This would have some positive effects on the quality of life.

Previous empirical studies indicated that perceived low-level health contributes to a low level of life satisfaction (e.g., see Gwozdz and Sousa-Poza (2009)). Our study indicates that a perceived good health condition (self_health) correlates positively with subjective life satisfaction for the elderly. However, the result is statistically inconclusive in our study. (*Line spacing after this paragraph?)

1.1 The Effects of Frailty and Perceived Income Sufficiency on the Elders' Life Satisfaction

Given the estimated predictors, one may wish to know the effect of change in life satisfaction if a person's health condition changed from "non-frail" to "pre-frail" or "frail". we predict the probability of specific level of subjective life satisfaction (LSF) for frailty and income sufficiency. Table 2 summarizes the predictive margins (odds) of this exercise.

5.1.1 Frailty and Subjective Life Satisfaction

Given other predictors in the model at their means, the probability of a non-frail elder (FRAIL=1) to report a "highly satisfied" life (LSF=1) is 0.436. The probability of a pre-frail elder (FRAIL=2) to report "highly satisfied" life (LSF=1) is 0.3602; whereas the probability of a frail elder (FRAIL=3) to report LSF=1 is 0.2922 (Table 2, Panel 2a). The probability of being "very happy" decreases with the development of frailty. On average, the probability of "non-frail" elders to report "highly satisfied" life is 1.49 times as likely as the average of frail elders.

On the other hand, the probability of reporting a "highly unsatisfied" life (LSF=4) increases with the development of physical frailty. For the three categories of frailty (non-frail, pre-frail, and frail), the probability of an elder to report "highly unsatisfied" life (LSF = 4) changed from 0.0058 to 0.08, and 0.108. That is, for a person whose physical condition changed suddenly from "non-fail" to "frail", his/her life satisfaction precipitates drastically. The empirical results suggest that independence in mobility is an important factor for the elders' life satisfaction.

5.1.2 Income Sufficiency and Subjective Life Satisfaction

Financial security keeps an individual free from the fear of insufficient supplies of materials for life. Panel 2b illustrates the predicted probability of income sufficiency on life satisfaction for an average elder. This study considers two income categories: subjective income being "not sufficient or far from sufficient" (income_strain=1) and being "sufficient or more than sufficient" (income_strain=2). An elder who feels himself to have sufficient income to spend is more likely to report high life satisfaction (LSF=3 & 4) than those who perceive themselves as "poor." On average, the probability of reporting "satisfactory life" (LSF=3 & 4) is 2.62 times that of the latter; the difference in the odds is 0.0646 to 0.0247. On the other hand, the probability for an elder with insufficient income to report a "highly unsatisfied" life (LSF=1) is 2.03 times that of the elders with subjective income sufficiency.

The empirical results indicate that income security is an important economic factor for the subjective life satisfaction of the elderly. Although social welfare income and financial support from offspring help in improving an elder's subjective life satisfaction, their effect is not as significant as perceived income sufficiency. That is, only in-pocket income that an elder can control matters for his subjective happiness.

Table 2: Predictive Margins of Key Predictors

Panel 2a: Effects of Physical Health Condition and Subjective Life Satisfaction						
		Delta-method				
Frail	Margin	Std. Err.	z	P>|z|	[95% Conf. Interval]	
at						
1	0.4360	0.0365	11.9300	0.0000	0.3644	0.5076
LSF=1 2	0.3602	0.0370	9.7400	0.0000	0.2877	0.4326
3	0.2922	0.0584	5.0000	0.0000	0.1777	0.4067
at						
1	0.5422	0.0354	15.3100	0.0000	0.4728	0.6116
LSF=2 2	0.6101	0.0359	16.9800	0.0000	0.5397	0.6805
3	0.6677	0.0492	13.5700	0.0000	0.5712	0.7641
at						
1	0.0160	0.0048	3.3400	0.0010	0.0066	0.0254
LSF=3 2	0.0218	0.0063	3.4600	0.0010	0.0094	0.0341
3	0.0293	0.0116	2.5300	0.0110	0.0066	0.0519
at						
1	0.0058	0.0023	2.5000	0.0120	0.0013	0.0104
LSF=4 2	0.0080	0.0031	2.5600	0.0100	0.0019	0.0141
3	0.0108	0.0050	2.1500	0.0320	0.0009	0.0207

Note: Frail at 1: Non-frail; 2: Pre-frail; 3: Frail.

Panel 2b: Effects of Income Strain Status on Subjective Life Satisfaction						
		Delta-method				
Income strain	Margin	Std. Err.	z	P>|z|	[95% Conf. Interval]	
at						
LSF=1 1	0.4059	0.0264	15.3500	0.0000	0.3540	0.4577
2	0.1998	0.0523	3.8200	0.0000	0.0973	0.3023
at						
LSF=2 1	0.5695	0.0267	21.3000	0.0000	0.5171	0.6219
2	0.7356	0.0410	17.9200	0.0000	0.6551	0.8160
at						
LSF=3 1	0.0181	0.0052	3.4800	0.0010	0.0079	0.0282
2	0.0468	0.0165	2.8400	0.0040	0.0146	0.0791
at						
LSF=4 1	0.0066	0.0025	2.5900	0.0100	0.0016	0.0116
2	0.0178	0.0080	2.2200	0.0260	0.0021	0.0335

Note: Income strain at 1: Not sufficient or far from sufficient; 2: Sufficient or more than sufficient

1.2 The Impacts of Changes in Health Conditions on Subjective Life Satisfaction

The estimated model in Table 1 indicates that the occurrence of a cerebral vascular accident (CVA) has a significant adverse impact on the life satisfaction of the elderly. We are interested in knowing the impact of a CVA and the subsequent frailty on the elder's subjective life satisfaction. In this section, we first explore the impacts of degradation of physical condition from "non-frail" to "pre-frail", and from "pre-frail" to "frail" have on life satisfaction of the elderly. We then explore the case where there is an occurrence of CVA and then there are changes

in frailty. We investigate the effects of these changes on the elders' life satisfaction. Table 3 illustrates the changes in the predicted margins of these scenarios.

Given other predictors in Model 2 at their means, if an elder whose physical condition deteriorates from "non-frail" to "pre-frail" and from "pre-frail" to "frail", his life satisfaction will decrease (Panel 3a in Table 3). The probability for this elder to report a "highly unsatisfied" life (LSF=1) will increase by 2.86% if his health degraded from "non-frail" to "pre-frail". If his physical condition further worsened to being frail, the probability for him to report a "highly unsatisfied" life will increase further by 6.63%. On the other hand, given the same health development, the probability for him to report a "pleasant life" (LSF=3&4) will decrease by 3.52% if he becomes a "pre-frail", and drop further by 6.36% if his health condition further deteriorated. In other words, fraity increases the probility of reporting an unpleasant life. The adverse effect is more noticable if an individual's physical condition deteriorated from "pre-frail" to "frail".

As shown in the estimates of Model 2, a cerebral vascular accident (CVA) has a significant adverse impact on the elders' life satisfaction. On the precondition of CVA, what would be on life satisfaction if there were also physical impairments to the elder's physical functionality? Panel 3b in Table 3 illustrates the changes in the predictive margins of such circumstances. For an average elder whose physical functionality degraded from "non-frail" to "pre-frail", the probability that he would report a "highly unsatisfied" life (LSF=1) would increase by 6.85%, and increase by 14.6% if his physical functionality further degraded to "frail". On notices that the increase in the "unhappiness" would increase more than doubled, compared with that in the frailty alone case. The probability to report a pleasant life (LSF=3&4) would also decrease likes that in the frailty alone case. However, the decline in the probability is less than one-third of that in the frailty alone case.

Physical functionality is important for social connection and participation. Frailty would affect social participation. People who conceive themselves with high socioeconomic status used to participate actively in social activities. The extent that frailty impairs the life satisfaction of such a high self-perceived socioeconomic status (SEAS) may differ from those elders with low self-perceived status. Given the other predictors in Model 2 at their means and set the preconditions that the elder in interest has a high self-evaluated socioeconomic status and reports himself as been experienced CVA treatments, we report the predicted probability changes of this investigation in Panel 3b.

No matter what the elder's perceived socioeconomic status is, frailty reduces the life satisfaction of an elder who has a CVA experience. However, we observe that the psychological responses of high SEAS elders to frailty are different from that of the average elders. In the case when the elder's health degrades from "non-frail" to "pre-frail", a high SEAS elder is less likely to report miserable life (LFS=1) than the average elders. The predicted probability increases only by 4.32%, which is less than the increase of 6.85% in the average elder in Panel 3b. Once the elder's health condition deteriorated form "pre-frail" to "frail", the predicted probability for the high SEAS elder to report a pleasant life (LSF=3&4) will drop by 4.01%, compared to the drops of 1.8% in the average elders. This result implies that social connection is important for people with high socioeconomic status. Frailty impairs physical capability and the loss of physical ability implies the loss of social connection and self-identity. The psychological loss and distress pressure to life satisfaction would be much intense for the high SEAS elders than the average elders. This is why we noticed that in the estimations of Model 2, self-perceived socioeconomic is positively correlated with subjective life satisfaction yet its effect is not statistically significant, because high SEAS has another negative impact on the physically deteriorated elders. Overall, self-perceived socioeconomic status plays an insignificant role in explaining the life satisfaction of the elderly.

Table 3. The Effects of Changes in Life Satisfaction Due to Changes in Frailty and CVA

Panel 3a: The Effects of Changes in Frailty

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf. Interval]	
1. Non-Frail (Base outcome)						
2. Pre-Frail _predict						
LSF=1	0.0286	0.0298	0.96	0.337	-0.0298	0.0869
LSF=2	0.0066	0.0271	0.24	0.808	-0.0465	0.0597
LSF=3	-0.0240	0.0284	-0.84	0.399	-0.0797	0.0317
LSF=4	-0.0112	0.0143	-0.78	0.434	-0.0392	0.0169
3.Frail _predict						
LSF=1	0.0663	0.0365	1.82	0.069	-0.0053	0.1379
LSF=2	-0.0027	0.0490	-0.06	0.956	-0.0988	0.0934
LSF=3	-0.0438	0.0318	-1.38	0.168	-0.1061	0.0184
LSF=4	-0.0198	0.0169	-1.17	0.241	-0.0529	0.0133

Note: dy/dx for factor levels is the discrete change from the base level.

Panel 3b: The Joint Effects of Changes in Frailty and CVA

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf. Interval]	
1. Non-Frail (Base outcome)						
2. Pre-Frail _predict						
LSF=1	0.0685	0.0686	1.00	0.318	-0.066	0.203
LSF=2	-0.0583	0.0569	-1.02	0.306	-0.170	0.053
LSF=3	-0.0074	0.0088	-0.84	0.402	-0.025	0.010
LSF=4	-0.0028	0.0034	-0.83	0.408	-0.009	0.004
3. Frail _predict						
LSF=1	0.1460	0.0688	2.12	0.034	0.011	0.281
LSF=2	-0.1280	0.0579	-2.21	0.027	-0.241	-0.015
LSF=3	-0.0131	0.0091	-1.44	0.150	-0.031	0.005
LSF=4	-0.0049	0.0036	-1.38	0.168	-0.012	0.002

Note: dy/dx for factor levels is the discrete change from the base level.

Panel 3c: The Effects of Health Deteriorations with Socioeconomic Status

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf. Interval]	
1. Non-Frail (Base outcome)						
2. Pre-Frail _predict						
LSF=1	0.0432	0.0449	0.96	0.335	-0.0447	0.1311
LSF=2	-0.0208	0.0333	-0.62	0.533	-0.0860	0.0445
LSF=3	-0.0159	0.0206	-0.77	0.44	-0.0562	0.0245
LSF=4	-0.0066	0.0090	-0.73	0.464	-0.0242	0.0110
3. Frail _predict						
LSF=1	0.0978	0.0570	1.71	0.086	-0.014	0.210
LSF=2	-0.0577	0.0625	-0.92	0.356	-0.180	0.065
LSF=3	-0.0285	0.0243	-1.18	0.24	-0.076	0.019
LSF=4	-0.0116	0.0109	-1.06	0.288	-0.033	0.010

Note: dy/dx for factor levels is the discrete change from the base level.

6. Conclusions

Frailty is a condition associated with the advance of aging. Biological aging evolved with the loss of muscle which marks a widespread syndrome associated with weakness, lower activity, slow-moving, low energy, and declines in health and function. Frailty is thus a physical impairment of health that restricts an individual's daily activity and morbidity. As a result, there is a negative association between frailty and the quality of life. This paper aims to investigate the association of frailty and the subjective life satisfaction of the elders in a community in Taiwan.

This study uses cross-sectional survey data collected from a face-to-face interview with a constructed questionnaire. The interview collects essential demographic, socio-economic information, lifestyle, medical history, and physical activity based on the International Physical Activity Questionnaire (IPAQ) of each subject. Unlike other studies uses perceived physical health as a proxy of health factor to predict subjective life satisfaction, the current study uses health information collected directly from the subject as predictors for the investigation. This study uses the definition of Fried *et al.* (2001) for frailty and applies an ordinal logistic regression model to investigate the predictors for subjective life satisfaction for the elderly.

The empirical results indicate that self-rated income sufficiency, biological gender difference, financial support from offspring and spouse, self-rated quality of family and social support, recent mood or psychological condition are statistically significant predictors of life satisfaction for the elderly. Besides, physical health impairments that retard daily activity, such as frailty and cerebral vascular accident, are significant predictors of adverse life satisfaction of the elderly. There is also a negative association between diabetes mellitus and life satisfaction, though the negative effect is only significant at a 10% significance level. The empirical results also suggest that frailty has a strong negative impact on the affected elders' life satisfaction, especially for those who perceived themselves to be in high socio-economic status. Income security is also an important factor for elders' life satisfaction. However, it is not the source of income but the perceived sufficiency of income that is the important factor for economic security.

The empirical results conclude that, among various important predictors of elders' life satisfaction, physical functionality and economic security are the most important determinants for elders' life satisfaction. Physical health is an asset that is irreplaceable by any otherworldly assets or relationship, whereas economic resources are indispensable for the support of the body and physical health. Biological factors or personality traits of an elder, such as gender and status of social support, are hard to alter by policy measures. However, policy or institutional arrangements can help in mitigating the elders' health and economic hardness. Therefore, economic or social welfare policy should aim to improve the economic security of the elderly. Some socio-economic policies like encouraging savings in the pre-retirement working-time, maintaining a sound and stable economic and financial system, and providing entitlement protection for the elderly, can improve the economic security for the elderly. Public health policies aim to provide medical care and interference to prevent or delay the development of frailty in the elderly also helps in improving life satisfaction for them.

Ethics

The study was approved by the Human Experiment and Ethics Committee at National Cheng Kung University Hospital, registration #ER-101-125. All subjects provided written consent for participation in the study.

References

Abu-Bader, S.H., A. Rogers, and A.S. Barusch. (2002). Predictors of life satisfaction in frail elderly." *Journal of Gerontological Social Work,* Vol. 38 (3), 3-17.

Argyle, M. (2002). *The psychology of happiness.* London - New York: Routledge.

Avila-Funes JA, Helmer C, Amieva H, Barberger-Gateau P, *et al.* (2008). Frailty among community-dwelling elderly people in France: The three-city study. *Journals of Gerontology. Series A (Biological Sciences and Medical Sciences)* 63, 1089-1096.

Blanchflower, D. G., and Oswald, A. J. (2008). Hypertension and happiness across nations. *Journal of Health Economics*, 27: 218–33.

Chen, (2001). Aging and life satisfaction." *Social Indicators Research* 54, 57–79.

Clark, Andrew E., Paul Frijters, and Michael Shields (2008). "Relative income, happiness, and utility: An explanation for the Easterlin paradox and other puzzles." *Journal of Economic Literature*. 46(1), 95-144.

Chou, K.L. and I. Chi (1999). Determinants of life satisfaction in Hong Kong Chinese elderly: A longitudinal study. *Aging & Mental Health*, Volume 3, Issue 4, 328-335.

Diener, E. et al. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, Volume 49, Issue 1, 71-75.

Diener, E., & Oishi, S. (2000). Money and happiness: income and subjective well-being across nations. In E. Diener & E. M. Suh (Eds.). *Culture and Subjective Well-being* (pp. 185-218). Cambridge, MA: MIT Press.

Frey, B. and A. Stutzer (2002). *Happiness and economics—How the economy and institutions affect human well-being.* Princeton University Press, New Jersey and Oxford, 2002.

Fried LP, Tangen CM, Walston J, et al. (2001). Frailty in older adults: evidence for a phenotype. *Journal of Gerontology Medical Science.* 56A: M146–M156.

Gerdtham, Ulf-G, and Johannesson, Magnus (1997). New estimates of the demand for health: results based on a categorical health measure and Swedish micro data. Working Paper Series in Economics and Finance 205, Stockholm School of Economics.

Gwozdz, w., and Alfonso Sousa-Poza (2009). Ageing, health and life satisfaction of the oldest old: an analysis for Germany. *IZA Discussion Papers* No. 4053, March 2009. [Online] Available: http://ftp.iza.org/dp4053.pdf

Hlavac, Marek (2011). Subjective life satisfaction in the European Union: determinants and policy implications (May 26, 2011). [Online] Available: http://ssrn.com/abstract=1853623

Kahneman, Daniel; Krueger, Alan B. (2006). Developments in the measurement of subjective well-being. *The Journal of Economic Perspectives*, Volume 20, Number 1, 3-24.

Kapteyn, A., J.P. Smith, and A. van Soest (2009). Life satisfaction. *IZA Discussion Paper* No. 4015. [Online] Available: http://ftp.iza.org/dp4015.pdf.

Layard, Richard (2005). *Happiness: lessons from a new science.* Penguin, London, UK.

Mhaolain, A., et al. (2012). Subjective well-being amongst community-dwelling elders: what determines satisfaction with life? Findings from the Dublin Healthy Aging Study. *International Psychogeriatrics,* 02/2012; 24(2), 316-23.

Pinquart, M. (2001). Correlates of subjective health in older adults: a meta-analysis. *Psychology and Aging.* 16 (3):414-26.

Tiefenbach, Tim, and Florian Kohlbacher (2013). Happiness and life satisfaction in Japan by gender and age." German Institute for Japanese Studies (DIJ), *Working Paper 13/2.* [Online] Available: http://www.dijtokyo.org/publications/WP1302_Tiefenbach_Kohlbacher.pdf

United Nations (2015). *World Population Aging Highlights.* Department of Economic and Social Affairs, United Nations. [Online] Available: http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Highlights.pdf

Veenhoven, R. (2012). Happiness, also known as "Life Satisfaction" and "Subjective Well-Being." Chap. 3 in Kenneth C. Land, Alex C. Michalos, and M. Joseph Sirgy (eds.). *Handbook of Social Indicators and Quality of Life Research*, Springer Netherlands, 63-77.

Wu, CH, et al. (2014). Prevalence and associated factors of sarcopenia and severe sarcopenia in older Taiwanese living in a rural community: the Tianliao old people study 04. *Geriatrics & Gerontology International* 14: 69-75.

Yang, F., Gu, D., and A. Mitnitski, (2016). Frailty and life satisfaction in Shanghai older adults: The roles of age and social vulnerability. *Archives of Gerontology and Geriatrics*. 67: 68-73.